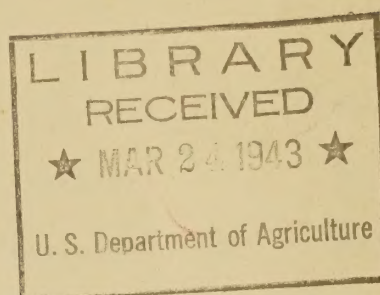


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ESTIMATES OF EQUIPMENT COSTS AND LABOR REQUIREMENTS  
IN  
VEGETABLE DEHYDRATION.

Plant Capacity---400 Pounds Per Hour  
(Unprepared Basis)



Note:

Preparation, final inspection and packaging equipment are the only types of equipment considered in this report. All labor requirements except clerical and shipping are included.

August 1942

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Preparation, Final Inspection, and Packaging Equipment,  
and Labor Requirements in  
Vegetable Dehydration at a Plant Capacity of 400 Pounds per Hour,  
Unprepared Basis

This discussion deals with preparation and packaging equipment costs and labor requirements in dehydration plants capable of handling 400 pounds per hour, unprepared basis. It is apparent that the tonnage handled is directly proportional to the length of the operating day, which in turn will depend upon the drying time and the number of batches dried per day. Plants this size will usually operate with batch (cabinet type) driers.

Since the operation in these small units cannot be continuous, it will be necessary to hold the vegetables somewhere along the preparation line in order to accumulate enough material to fill a car completely. The following table presents the maximum allowable holding times as given in the Tentative Federal Specifications:

Vegetable	After Cutting		
	Holding in air	Holding in Water or in Brine	After Blanching
Beets	:	:	:
Cabbage	:15 minutes	: 1 hour	: 2 hours
Carrots	:30 "	:: 1 "	: 2 "
Onions	: 2 hours	:	:
Potatoes	:30 minutes	: 3 hours	: 3 hours
Sweet potatoes (Yams)	:30 "	: 3 "	: 3 "
Turnips (Rutabagas)	:	:	: 2 "
	:	:	:

It, therefore, appears that the only place to hold the vegetables to allow for most efficient operation is after blanching; in the case of onions, which are not blanched, holding after slicing is satisfactory. When all seven vegetables are considered, the allowable maximum holding time is 2 hours. In working out uniform operating details for plants, no more than two hours should be allowed in loading cars and getting them into the driers. Assuming that the total tray surface of each car will be around 400 square feet, with preparation losses and loading per square foot as mentioned below, the hourly capacity with which this discussion deals will not require a waiting period of over 2 hours on any of these seven vegetables.

The lists of equipment given herein and indicated methods of operation are intended to be merely suggestive. Other items of



equipment as well as other operating procedures may be equally satisfactory or even better. For instance, mechanical abrasive peelers have been assumed. Lye peeling, if permitted by the purchase specifications, may be preferable on carrots, potatoes, and other hard root vegetables. Other peeling methods, for example, carbonization by flame or radiant heat, followed by vigorous scrubbing, have also shown promise on an experimental basis. Carrots, turnips, and beets are shown as being peeled before topping. Under certain conditions it may be advisable to do the topping before peeling and the trimming after peeling. Standard abrasive peelers have not proven entirely satisfactory on onions. Operators have adopted various expedients to overcome this difficulty.

Costs and descriptions of equipment are based upon prices and information from established manufacturers in this field. The labor set-ups shown are based upon cannery operations and the operations of present commercial dehydrators. It is, of course, not possible to utilize labor efficiently in such a small scale plant as is herein considered, and allowance has been made for this fact. If the items of equipment or sequence and methods of operations are different from those given here, the labor set-up must be modified accordingly.

Items of equipment have been listed in greater detail for this size plant because the cost of small items is a relatively greater proportion of the total equipment cost. The operator will have to improvise equipment even more for a plant this size than has been suggested for the larger size plants. Satisfactory small equipment is difficult to obtain, the small units usually lacking the ruggedness necessary for continuous operation. Unless the operator can devise some substitute, he will have to purchase cannery size equipment. For instance, the smallest satisfactory motor driven slicer we have listed sells for \$475. If some inexpensive and sufficiently sturdy device could be made that would allow the women, upon completion of trimming, to slice each vegetable with a simple push of a lever by hand or foot, this would eliminate one handling step and at the same time reduce the amount of money needed to purchase the slicing equipment. A small hand-operated machine is available for stripping potatoes; its cost is \$25.

Only one form of prepared vegetable has been considered. Preparation of the vegetables in other forms will necessitate the installation of other types of cutters and will usually entail an increase in cost. However, if all vegetables were to be strip-cut, a saving in equipment cost might be accomplished. The labor set-up may also be affected to some extent by resulting differences in blancher loading, tray loading, and drying time.

A water spray at the beginning of the blancher belt is quite satisfactory in washing the diced, sliced, or stripped vegetables.



A separate washer to do the same work may cost several hundred dollars. If the washing is manual, the services of another employee may be required. Such a water spray at the front end of the blancher belt tends to prevent excessive humidity in the preparation room by condensing steam escaping from this end of the blancher. The amount of steam necessary for blanching will vary from plant to plant depending upon losses from the blancher and care in the avoidance of steam wastage. The range may be from 1 to 3 boiler horsepower for each ton of unprepared vegetables handled per 24-hour period. Except for beets and sweet potatoes, a requirement of 2 boiler horsepower per ton per day has been assumed. Due to retort blanching used for beets, a slightly larger amount is considered necessary. Sweet potatoes are scalded as well as blanched. Due to this double heating, they require somewhat more steam capacity. The plant operator can lessen the investment in steam boilers by insuring proper plant operation to minimize the steam losses and by operating the steam boiler above its rated capacity.

The standard drying tray is 3' x 6'. This size requires two men to lift it onto the car. It is probably better in a small plant to use 3' x 3' trays, which require only one man to handle them. This is an important factor where labor is used somewhat inefficiently due to the necessity of having an employee perform only one or two operations regardless of the throughput at any particular point.

The balance between labor and machinery is a factor that is very important. The initial cost of a labor-saving machine may be large, but the labor cost saved may be much larger than the annual charge on the machine, even in a plant as small as the one considered here. Raised platforms and discharge chutes will greatly assist in reducing handling costs.

The cost of packaging equipment is based on the assumed use of 5-gallon cans. Recent practice has been to solder the top after filling the can with inert gas. A regulator valve for the gas, relatively inexpensive soldering equipment, and scales are the main items needed for this type of packaging. Other types of packaging might involve a larger capital investment. Automatic can sealers have been recently introduced. These use a plastic sealing material under the edge of the lid which eliminates the necessity for soldering. No increased capital investment is ordinarily involved in the use of the automatic can sealer since the machines are leased to the user. In a small plant such as the one considered here, it is questionable if the use of such a can sealer could be economically justified on the basis of cost alone.

No provision for waste disposal equipment has been made in these estimated costs. Since disposal of waste is a very important and sometimes costly factor, it cannot be overlooked in setting up a plant.



Due to the many factors involved, no attempt is being made at this time to show the cost of such equipment. Economical disposal of preparation wastes will usually require some ingenuity on the part of plant operators.

An allowance of 40% has been made for installation and accessory equipment. Since most of the conveying and elevating will be done manually, no additional allowance has been made for improvised items. Equipment has been listed in greater detail for this size plant than for the larger ones because small items are relatively more important.

It is assumed that the extra men shown on the accompanying charts will assist in actual processing of the material, in care and operation of the equipment, and in removal of wastes from the plant. It has not been indicated on the flowsheets if a man does more than one operation. Each man's work is, however, described on separate sheets which itemize equipment and labor requirements.

Since actual working time in an 8-hour shift may be only 7 hours, the indicated hourly capacities are only intended to be an average of the quantities handled during an 8-hour shift. Quantities handled in any one hour of actual operation will have to be slightly higher if the assumed rate of production is to be maintained throughout a complete shift. The number of employees indicated should as a rule be sufficient to cover this difference.

Daily input, based upon 400 pounds of unprepared product per hour, is as follows for different lengths of operating day on the preparation line:

4 hour preparation day	--	0.8 tons
8 " " "		1.6 "
12 " " "		2.4 "
16 " " "		3.2 "
24 " " "		4.8 "

# SUMMARY OF COSTS

Preparation, Final Inspection, and Packaging Equipment,  
and Labor Requirements in  
Vegetable Dehydration at a Plant Capacity of 400 Pounds per Hour

Unprepared Basis

Name of Vegetable	Shrinkage Ratio	Equipment Cost			Labor Cost	
		Total	Per Ton <sup>1/</sup>		Per Pound	
			Wet :	Dry	Wet :	Dry
			(Unpre- pared):		(Unpre- pared)	
		\$	\$	\$	\$	\$
Table beets	13 to 1	2,000	417.	5417.	1.98	25.5
Cabbage	19 to 1	2,095	436.	8293.	1.49	28.3
Carrots	10 to 1	2,665.	556.	5552.	1.79	17.9
Onions	14 to 1	1,240.	258.	3617.	1.45	20.5
Potatoes	7 to 1	2,245.	468.	3274.	2.09	14.7
Sweet Potatoes	4 1/2 to 1	3,015.	628.	2827.	1.79	8.0
Turnips	10 to 1	2,665.	556.	5552.	1.79	17.9

<sup>1/</sup> Equipment cost per ton handled per 24-hour day.



Capacities per Unit of Time  
in a Vegetable Dehydration Plant  
Capable of Handling 400 Pounds per Hour

(Unprepared Basis)

	Beets	Cabbage	Carrots	Onions	Potatoes	Sweet Potatoes (Yams)	Turnips
Form Prepared	Slices	Shreds	Slices	Slices	Strips	Slices	Slices
<u>Unprepared basis:</u>							
Tons per 24-hour day	4.8	4.8	4.8	4.8	4.8	4.8	4.8
Pounds " " " "	9,600	9,600	9,600	9,600	9,600	9,600	9,600
Pounds per hour	400	400	400	400	400	400	400
" " minute	6.7	6.7	6.7	6.7	6.7	6.7	6.7
No. of women coring		1					
Pounds per woman per hr.		400					
" " " " min.		6.7					
No. of retorts	2						
Blanching time in minutes	10						
Minutes per charge per retort -							
loading, blanching & unloading	20						
Charges per hour	6						
Pounds per charge	69						
Cars or crates per charge	2						
Pounds per car or crate	35						
<u>Prepared basis:</u>							
Assumed preparation loss	30%	25%	25%	15%	25%	25%	20%
Tons per 24-hour day	3.4	3.6	3.6	4.1	3.6	3.6	3.8
Pounds per 24-hour day	6,720	7,200	7,200	8,160	7,200	7,200	7,680
Pounds per hour	280	300	300	340	300	300	320
Pounds per minute	4.7	5.0	5.0	5.7	5.0	5.0	5.3
No. of women sorting, tipping & trimming	3		3	2	5	3	3
Pounds per woman per hour	95		100	170	60	100	105
Pounds per woman per minute	1.6		1.7	2.8	1.0	1.7	1.8
Assumed blancher loading -							
lbs. per square foot		1.5	2.0		2.0	2.0	2.0
Assumed blanching time in minutes		3	4		4	6	4
Pounds in blancher at any one time		15	20		20	30	21
Square feet of blancher needed		10	10		10	15	10.5
Assumed tray loading -							
lbs. per square foot	1.5	1.2	1.5	1.2	1.5	1.5	1.5
Pounds per car	590	475	590	475	590	590	590



Capacity per Unit of Time  
In a Vegetable Dehydration Plant  
Capable of Handling 400 Pounds per Hour (cont'd)

(Unprepared basis)

Sweet Potatoes Turnips

Beef's Cabbage Carrots Onions Potatoes (Vans)

Slices Shreds Slices Slices Strips Slices Slices

Cars per 24-hour day	11	15	12	17	12	12	13
Cars per hour	0.47	0.63	0.51	0.72	0.51	0.51	0.54
Trays per car	130	95	120	85	120	110	110
Trays per hour	44	44	44	44	44	44	44
Trays per tray	13.5	10.8	13.5	10.8	13.5	13.5	13.5
Cars per 24-hour day	500	700	530	750	530	530	570
Cars per hour	21	28	22	31	22	22	24
Trays per minute	0.35	0.47	0.37	0.52	0.37	0.37	0.40
Trays per tray	170	130	160	115	160	160	160

Notes:

Based on overall shrinkage

Ratio	19 to 1	10 to 1	14 to 1	7 to 1	4 1/2 to 1	
Trays per 24-hour day	10	960	85	1,370	2,130	
Trays per hour	21	40	29	57	89	
Trays per minute	0.35	0.67	0.48	0.95	1.5	

Cars per 5 gallon can	11	5	14	9	10	11
Cars per 24-hour day		100	70	76	140	165
Cars per hour		4.2	2.9	3.2	5.7	6.8
Trays per car		14	21	19	11	8.8







Unprepared Basic

Operation	Manpower	Work Done	Equipment Req
			Description
Trucking and Washing	1 M	Man trucks beets from receiving platform, washes them on a screen, and takes them to blanching retorts. He also assists with cleanup work.	Hand Truck Washing equipment
Blanching	1 M	Blanching is done in retorts, 10 minutes @ 5 lbs. pressure.	Small retorts 2 would make for more continuous operation 2 @ \$250.
Peeling		Blancher operator empties beets into peeling machine. From here they are fed to next table on a chute.	Batch peeler with 1/2 h.p. motor
Topping and	3 F	Topping and trimming done on a table.	Table 3' x 6'
Washing		Washing is done in a vat or trough	Vat or trough
Slicing	1 M	Beets are taken from water and fed to slicing machine. Employee doing this can also assist with cleaning up.	Slicer with 1/2 h.p. motor
	1 M	Slices are spread on trays and trays are placed on cars. Operation takes about 3 minutes. Man doing this also loads drier.	Tray table 3' x 3' trays should be used
		Foreman regulates drier	

Operation	Empl- oyees	Work Done	Equipment Necessary	
			Description	Approx. Cost
Scraping Trays, Packaging and Preparing for Shipping	1 F 1 M	2 people inspect and scrape trays, then package and crate product. Together, they can unload a car in about 30 minutes, or about 1/4 the time required to load a car. The remainder of time, until next car comes out of drier, can be spent in packaging.	Table and bin Scales, table and sealing equipment	\$ 50. 40.
General	1 M 1 M	Foreman Helper, cleanup, washing trays, and maintenance.		
			Sub-total	\$1,430.
		Add 40% for installation and accessory equipment		570.
			Total	\$2,000.
		Equipment cost per ton handled per 24-hr. day (unprepared basis).		\$ 417.
Labor Cost		Total Labor Requirements:	Total Labor Cost, Per Hour	
		4 Women @ 60¢ per hour	\$2.40	
		6 Men @ 75¢ per hour	4.50	
		1 Foreman	1.00	\$ 7.9
		Labor cost per wet pound (400 pounds)		
		Labor cost per dry pound (31 pounds)		25.2
Steam Generating		About 12½ boiler horsepower required for blanching Cost estimated on basis of rated horsepower	Approx. cost	\$1,400.

Labor  
 New, Repair, Rental Inspection and Packaging Equipment, and  
 Labor Requirements  
 for a Dehydration Plant Capable of Handling 400 Pounds per Hour

Unprepared Basis

Operation	Empl- : oyees :	Work Done	Equipment Necessary	
			Description	Approx Cost
Trucking to Coring Table	1 M	Man trucks cabbage from receiving platform to trimming and coring table. He also assists where needed.	Hand truck	2 15
Trimming and Coring	1 F	Coring can be done on an improvised corer located over a table	Improvised cabbage corer with 1/4 h.p. motor	
		This washing can be accomplished by putting cabbage into water vats after coring. Any further washing if necessary can be done by hand.	Table 2'x4'	
			Vat	
	1 M	Cabbage is removed from water vats and placed in shredder. Employee doing this also spreads cabbage on blancher belt.	Kraut cutter 21" disc with 1/2 h.p. motor	
Blanching		3 minute blanch. Loading on belt, 1 1/2 pounds per square foot.	Wire belt blancher, over all length, covered area, 12" x 10" with 1/2 h.p. motor	1,300
Tray loading and Stacking	1 M	Shreds are spread on trays and trays are stacked on cars. Operation takes about 2 minutes. Man doing this also loads drier.	Tray table 3' x 3' trays should be used.	
Drying		Foreman regulates drier.		



Operation	Empl. : oyees :	Work Done	Description	Approx. Cost
Scraping Trays, Packaging and Preparing for Shipping	1 F 1 M	2 people can inspect and scrape trays, then package and crate product. Together they can unload a car in about 30 minutes, or about 1/3 the time required to load a car. The remainder of time, until the next car comes out of drier, can be spent in packaging.	Table and bin Scales, table and sealing equipment	\$ 50. 40.
General	1 M 1 M	Foreman Helper, cleanup, washing trays, and maintenance.		
			Sub-total	\$1,496
		Add 40% for installation and accessory equipment.		600
			Total	\$2,096
		Equipment cost per ton handled per 24-hr. day (unprepared basis).		\$ 436
Labor Cost		Total Labor Requirements:	Total Labor Cost, Per Hour:	
		2 Women @ 60¢ per hour	\$1.20	
		5 Men @ 75¢ per hour	3.75	
		1 Foreman	1.00	\$ 5.95
		Labor cost per wet pound (400 pounds)		
		Labor cost per dry pound (21 pounds)		28.3
Generating		About 10 boiler horsepower required for blanching	Approx. Cost	21.00
		Cost estimated on basis of rated horsepower		

# Food Requirements

In a Canning Plant Capable of Handling 400 Pounds per Hour

Unprepared Basis

Operation	: cyees :	Work Done	Equipment Necessary : Description
Trucking and Washing	: 1 M :	: Man trucks carrots from receiving platform, washes them on a screen, and places them in peeling machine	: Hand truck : Washing : equipment
Peeling	:	: Carrots are conveyed from peeler to trimming table on a chute.	: Batch : peeler with : ½ h.p. motor
Topping and Trimming	: 3 F :	: Topping and trimming done on a table.	: Table : 3' x 6'
Slicing	: 1 M :	: Carrots are taken from table and fed to slicing machine. Employee doing this also spreads slices on blancher belt.	: Slicer with : ½ h.p. motor
Washing	:	: Sprays on front end of blancher. Included in blancher cost.	:
Blanching	:	: 4 minute blanch. Loading on belt, 2 pounds per square foot.	: Wire belt : blancher, over : all length, 17' : Covered area, : 12' x 10', with : ½ h.p. motor
Tray Loading and Stacking	: 1 M :	: Slices are spread on trays and trays are stacked on cars. Operation takes about 2½ minutes. Man doing this also loads drier.	: Tray table : 3' x 3' trays : should be : used
Frying	:	: Foreman regulates drier.	:

# CAREOTS (continued)

Operation	Empl- oyees	Work Done	Equipment Necessary	
			Description	Approx. Cost
Scraping Trays, Packaging and Preparing for Shipping	1 F 1 M	2 people inspect and scrape trays, then package and crate product. Together, they can unload a car in about 30 minutes, or about 1/4 the time required to load a car. The remainder of time, until next car comes out of drier, can be spent in packaging.	Table and bin Scales, table and sealing equipment	\$ 50 40.
General	1 M 1 M	Foreman Helper, cleanup, tray washing and maintenance		
			Sub-total	\$1,905.
		Add 40% for installation and accessory equipment.		760
			Total	\$2,665.
		Equipment cost per ton handled per 24-hr. day (unprepared basis).		1.80
Labor Cost		Labor Requirements:	Total Labor Cost Per Hour:	
		4 Women @ 60¢ per hour	\$2.40	
		5 Men @ 75¢ per hour	3.75	
		1 Foreman	1.00	
		Labor cost per wet pound (400 pounds)		1.79¢
		Labor cost per dry pound (40 pounds)		17.9¢
Steam Generating		About 10 boiler horsepower required for blanching Cost estimated on basis of rated horsepower	Approx.	\$1,200.

# ONIONS

Preparation, Final Inspection and Packaging Equipment, and Labor Requirements  
in a Drying Plant Capable of Handling 200 Pounds per Hour

## Unprepared Basis

Operation	Empl- oyees	Work Done	Equipment Necessary	
			Description	Approx. Cost
Trucking and Peeling	1 M	Onions are trucked from receiving platform to peeler. After peeling, onions are then conveyed to sorting and trimming table on a chute.	Hand truck Batch peeler with $\frac{1}{2}$ h.p. motor	\$ 15. 225.
Sorting and Trimming	2 F	Sorting and trimming is done on a table	Table 3' x 5'	40.
Washing		After trimming, onions are placed in water.	Vat	25.
Slicing		Man who puts onions into peeler takes them out of water and feeds them to slicing machine.	Slicer with $\frac{1}{2}$ h.p. motor	475.
Tray Loading and Stacking	1 M	Slices are spread on trays and trays stacked on cars. Operation takes about 2 minutes. Man doing this also loads drier.	Tray table 3' x 3' trays should be used	15.
Drying		Foreman regulates drier.		
Scraping Trays, Packaging and Preparing for Shipping	1 F 1 M	2 people can inspect and scrape trays, then package and crate product. Together they can unload a car in about 30 minutes, or about $\frac{1}{3}$ the time required to load a car. The remainder of time, until the next car comes out of drier, can be spent in packaging.	Table and bin Scales, table and sealing equipment	50. 40.



Chapter 1  
Introduction to the Study of  
Literature

What is Literature?  
The Study of Literature

What is the purpose of the study of literature?  
What are the different types of literature?

What are the different types of literature?

What are the different types of literature?  
What are the different types of literature?

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What are the different types of literature?  
What are the different types of literature?



Operation	Manpower	Work Done	Description	Cost
Tray loading and stacking	1 M	Strips are spread on trays and trays are stacked on cars. Operation takes about 2½ minutes. Man doing this also loads drier.	Tray table 3' x 3' trays should be used.	\$1.00
Drying		Foreman regulates drier.		
Scraping trays	1 F	2 people inspect and scrape trays, then package and	Table and bin	
Packaging	1 M	crate product. Together they can unload a car in about 30 minutes, or about ¼ the time required to load a car.	Scales, table and scaling equipment	
Preparing for shipping		The remainder of time, until next car comes out of drier, can be spent in packaging.		
	1 M	Foreman.		
	1 M	Helper, cleanup, washing trays and maintenance.		
			Sub-total	\$1.00
		Add 40% for installation and accessory equipment		\$0.40
			Total	\$1.40
		Equipment cost per ton handled per 24-hr. day (unprepared basis).		\$1.40
Labor Cost		Total Labor Requirements:	Total Labor Cost Per	
		6 women @ 60¢ per hour	\$3.60	
		5 men @ 75¢ per hour	3.75	
		1 foreman	<u>1.00</u>	
		Labor cost per wet pound (40 pounds)		
		Labor cost per dry pound (57 pounds)		
Steam generating		About 10 boiler horsepower required for blanching. Cost estimated on basis of rated horsepower	Approx. cost.	

Unprepared Basis

Operation	Emply- ees	Work Done	Equipment Necessary	
			Description	Approx Cost
Receiving	1 M	Sweet potatoes are trucked from receiving platform, placed on a screen and washed with a hose.	Hand truck	\$ 15.
Washing		After washing, sweet potatoes are put into baskets and hoisted into boiling water for a 10 minute scald.	Washing equipment	35.
			Wooden vat with steam pipes, hoist, etc.	150.
Peeling		Sweet potatoes are dumped from baskets into batch peeler. From peeler they are fed to trimming table on a chute.	Batch peeler with 1/2 h.p. motor	225.
Sorting and Trimming	3 F	Sorting and trimming is done on a table.	Table 3' x 6"	50.
Slicing	1 M	Trimmed sweet potatoes are placed in boxes and man carries them to slicer.	Slicer with 1/2 h.p. motor	475.
Blanching		Sprays on front end of blancher. Included in blancher cost.		
		6 minute blanch. Loading, 2 lbs. per sq. foot. Man who operates slicer spreads potatoes on blancher belt.	Wire belt blancher, over- all length, 23'	
			Covered area, 12" x 15", with 1/2 h.p. motor	
	1 M	Slices are spread on trays and trays stacked on cars. Operation takes about 2 1/2 minutes. Man doing this also loads drier.	Tray table	
			trays should be used	
		Foreman regulates drier.		



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TURNIP  
 FACTORY  
 Later Requirements  
 To a Dehydration Plant Capable of Handling 400 Pounds per Hour

Unprepared Basis

Operation	Empl- oyees	Work Done	Equipment Necessary	
			Description	Approx. Cost
Unloading and Sorting	1 M	Man trucks turnips from re- ceiving platform, washes them on a screen, and places them in peeling machine.	Hand truck Washing equipment	\$ 15 : 35
Peeling		Turnips are conveyed from peeler to trimming table on a chute	Batch peeler with $\frac{1}{2}$ h.p. motor	: : 225.
Topping and Trimming	3 F	Topping and trimming done on a table.	Table 3' x 6'	: 50.
Slicing	1 M	Turnips are taken from table and fed to slicing machine. Employee doing this also spreads slices on blancher belt.	Slicer with $\frac{1}{2}$ h.p. motor	: 475.
Washing		Sprays on front end of blancher. Included in blancher cost.		
Blanching		4 minute blanch. Loading on belt, 2 pounds per square foot.	Wire belt blancher, over- all length 18'	
			Covered area, 12" x 11', with $\frac{1}{2}$ h.p. motor	: 1,000.
Tray Loading and Stacking	1 M	Slices are spread on trays and trays are stacked on cars. Operation takes about 2 $\frac{1}{2}$ min- utes. Man doing this also loads drier.	Tray table 3' x 3' trays should be used	: 15.
Drying		Foreman regulates drier		

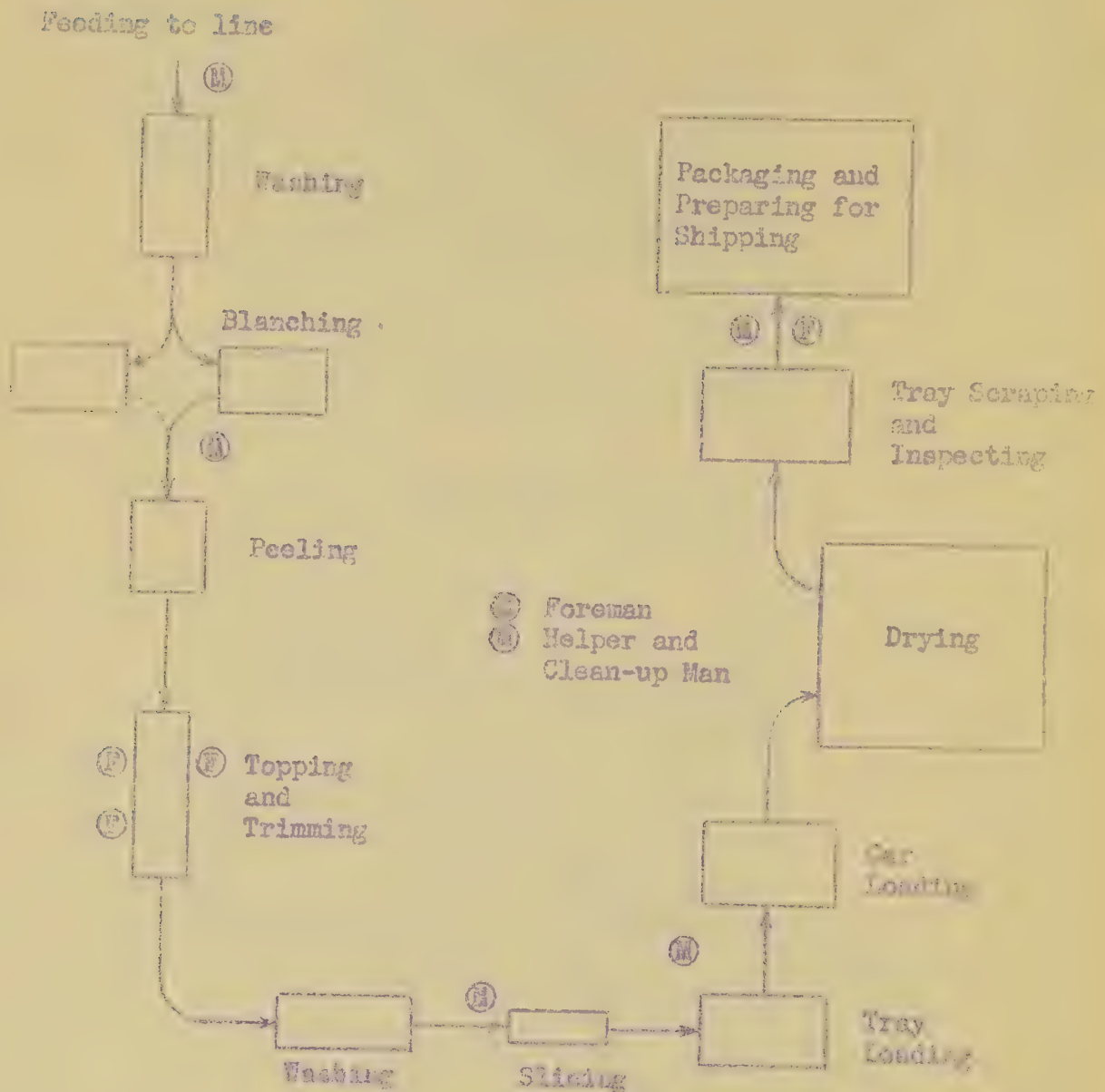
Operation	Work Done	Description	Equipment Needed
Scraping Tray , Packaging and Preparing for Shipping	: 1 F : 2 people inspect and scrape : 1 M : trays, then package and crate : product. Together, they can : unload a car in about 30 min- : utes, or about $\frac{1}{4}$ the time re- : quired to load a car. The re- : mainder of time, until next car : comes out of drier, can be : spent in packaging.	: Table and bin : Scales, table : and sealing : equipment	\$ 50 100
General	: 1 F : Foreman. : 1 M : Helper, cleanup, washing : trays and maintenance.	: Sub-total	11,700
	: Add 40% for installation : and accessory equipment	: Total	16,580
	: Equipment cost per ton handled : per 24-hr day (unprepared : basis)		1,580
Labor Cost	: Labor Requirements: : 4 women @ 60¢ per hour : 5 men @ 75¢ " " : 1 foreman	: Total Labor Cost Per Hour : \$2.40 : 3.75 : 1.00	7.15
	: Labor cost per wet pound : (400 pounds)		1.79
	: Labor cost per dry pound : (40 pounds)		19.24
Steam Generating	: About 10 boiler horsepower : required for blanching. : Cost estimated on basis of : rated horsepower.	: Approx. : Cost	11,000



# DEHYDRATION FLOW SHEET

400 Pounds per Hour

Unprepared Basis



Labor estimate per shift:

Foremen	-	1
Men	-	6
Women	-	4

Prepared by the Dehydration Committee,  
Bureau of Agricultural Chemistry and  
Engineering, United States Department  
of Agriculture, August 1942.

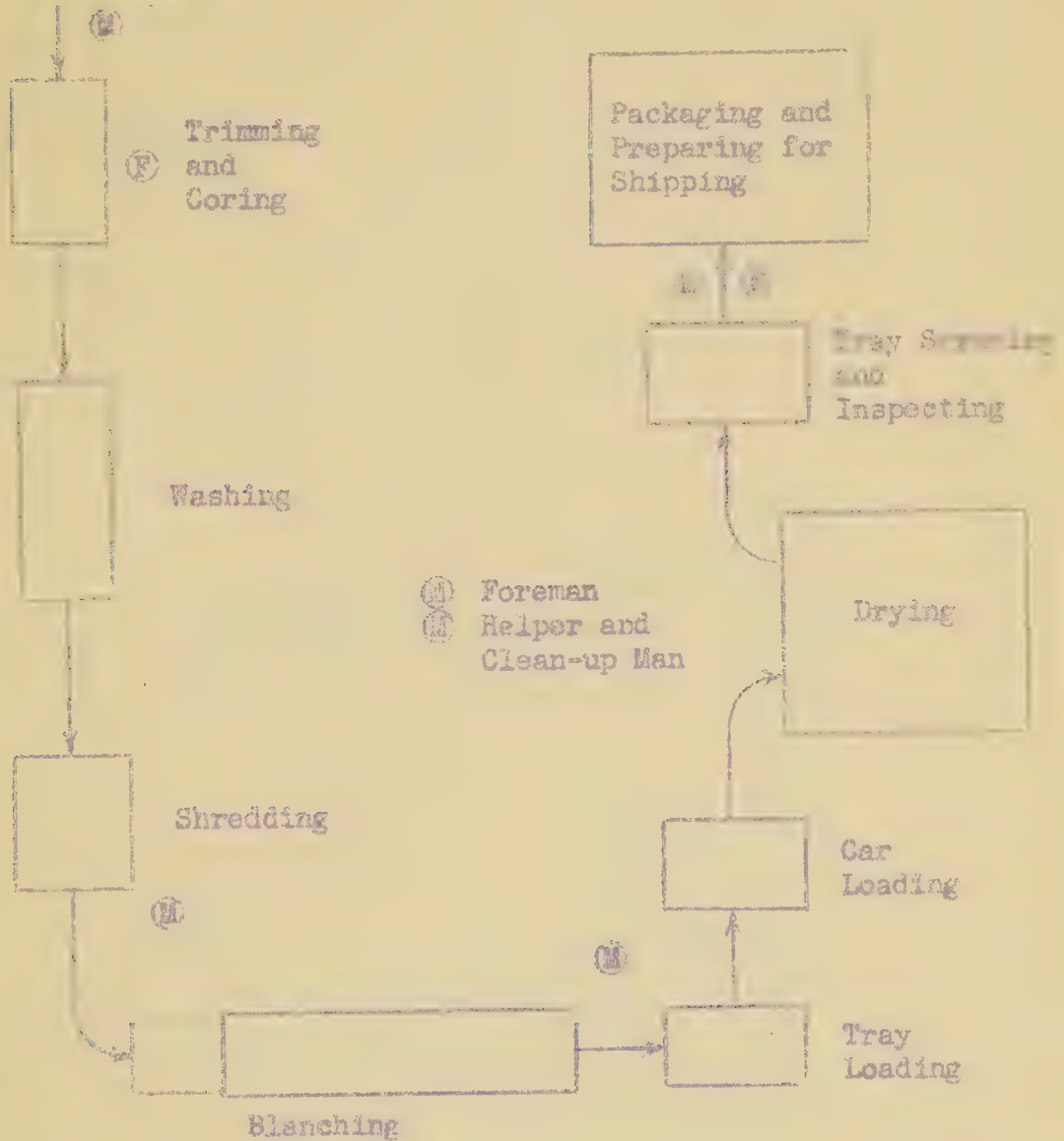
CA12801

# DEHYDRATION FLOW SHEET

400 Pounds per Hour

Unprepared Basis

Feeding to line



labor estimate per shift:

Foremen	-	1
Men	-	5
Women	-	2

Prepared by the Dehydration Committee,  
Bureau of Agricultural Chemistry and  
Engineering, United States Department  
of Agriculture, August 1942.



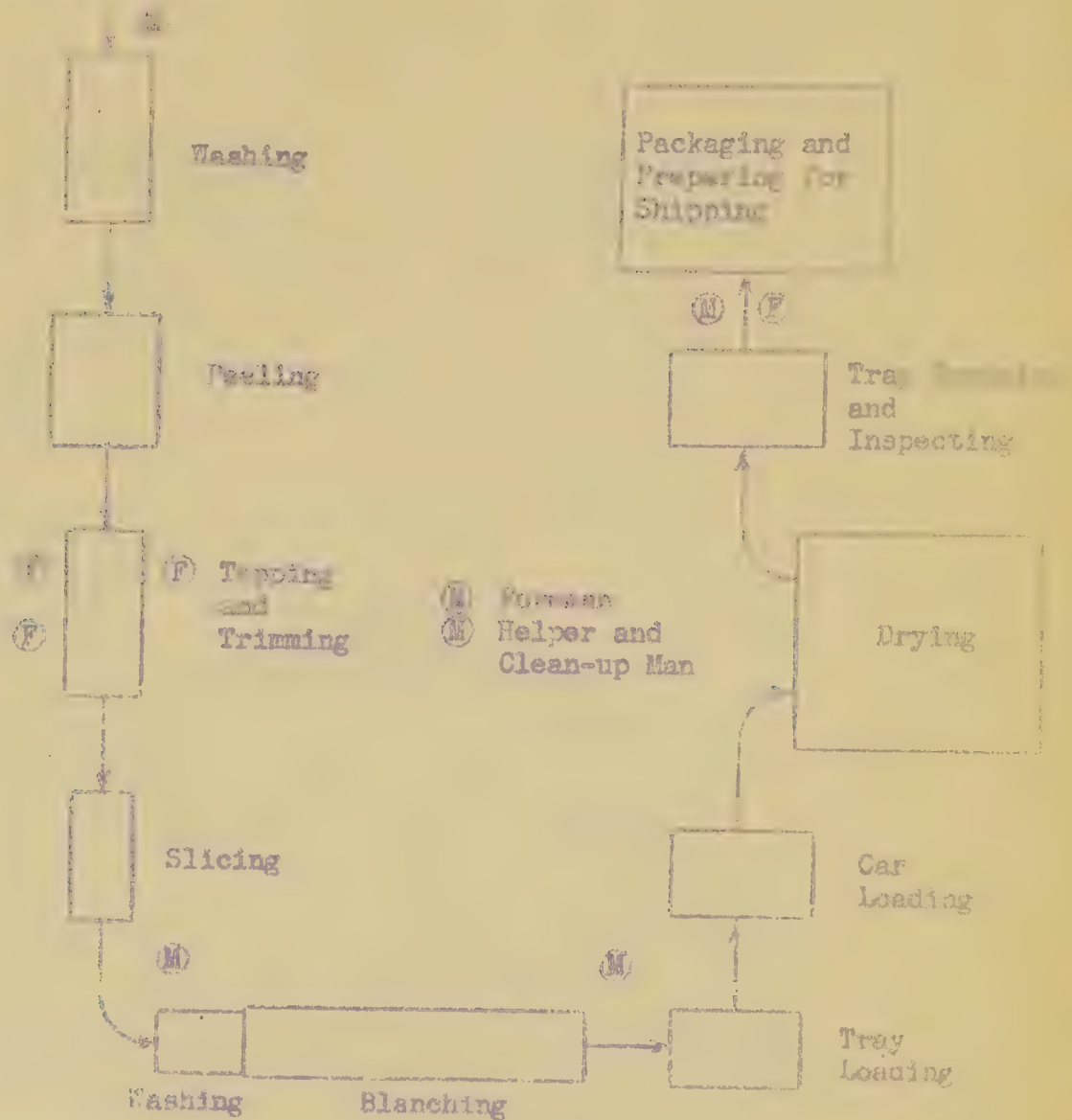
228675

# DEHYDRATION FLOW SHEET

400 Pounds per Hour

Unprepared Basis

Feeding to line



Labor estimate per shift:

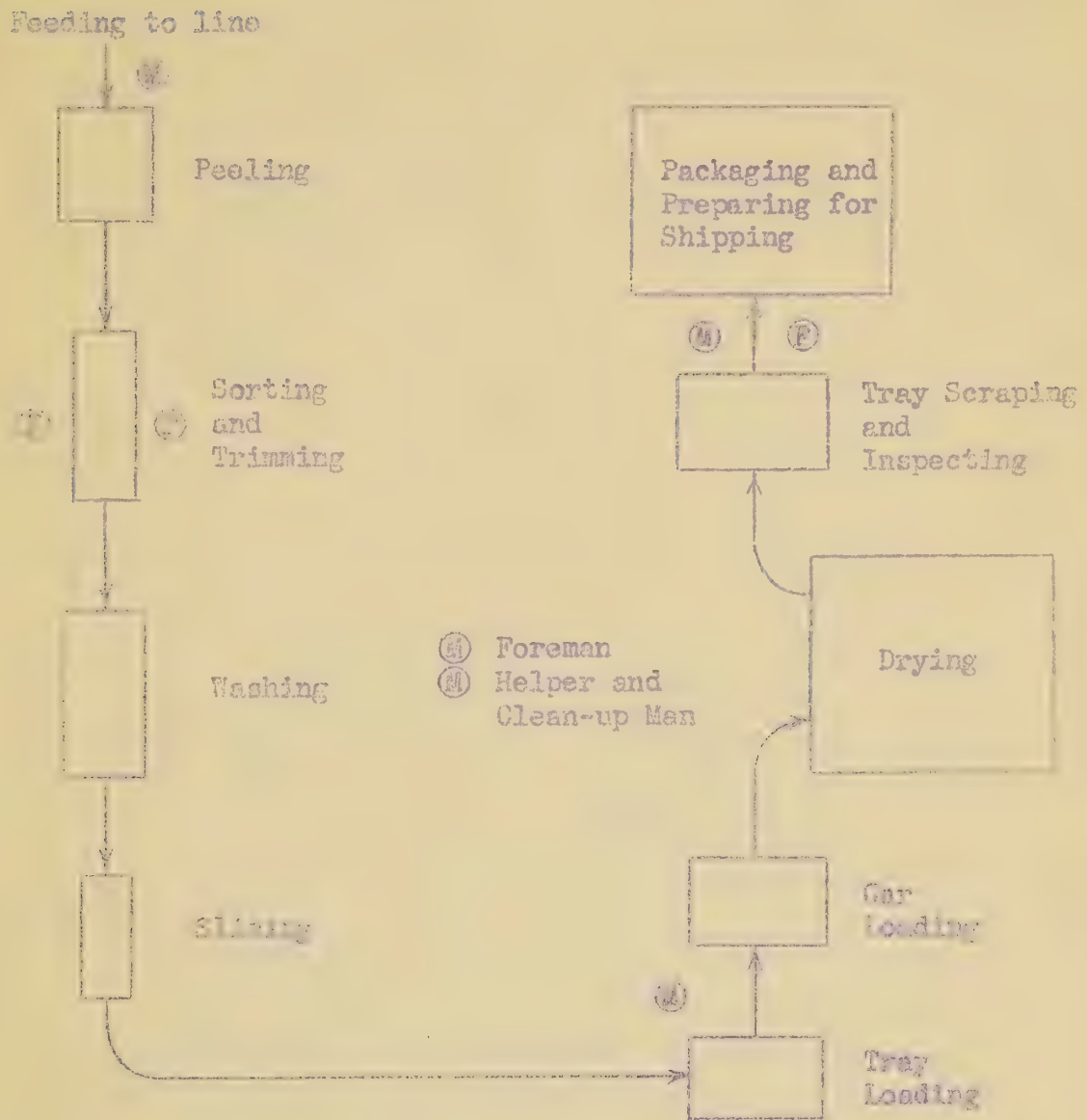
Foreman	-	1
Men	-	5
Women	-	4

ON FORM

# DEHYDRATION FLOW SHEET

400 Pounds per Hour

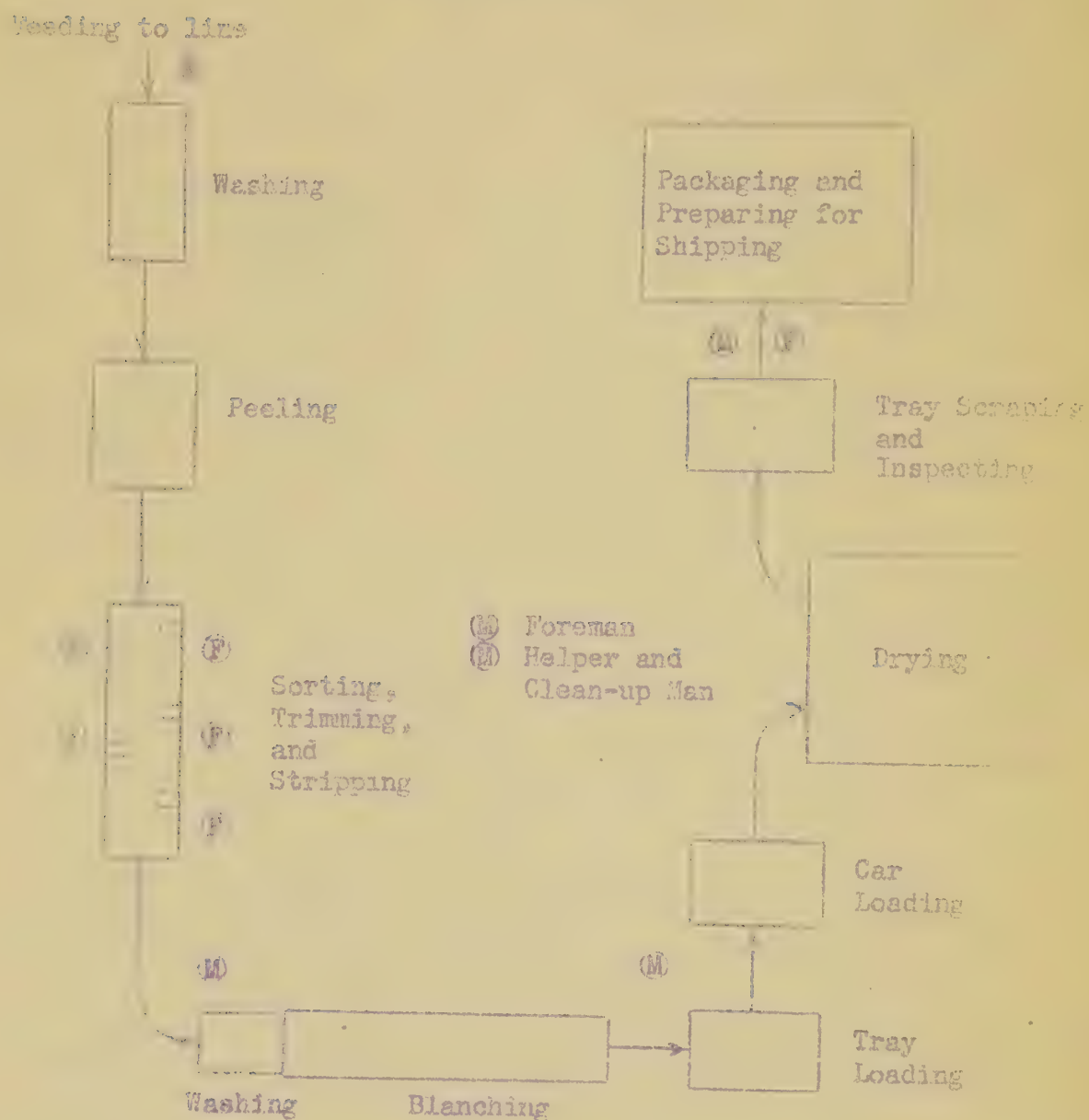
Unprepared Basis



## Labor estimate per shift:

Foremen	-	1
Men	-	4
Women	-	3

DEHYDRATION PLANT SKETCH  
 400 Pounds per Hour  
 Unprepared Basis



Labor estimate per shift:

Foremen	-	1
Men	-	5
Women	-	6

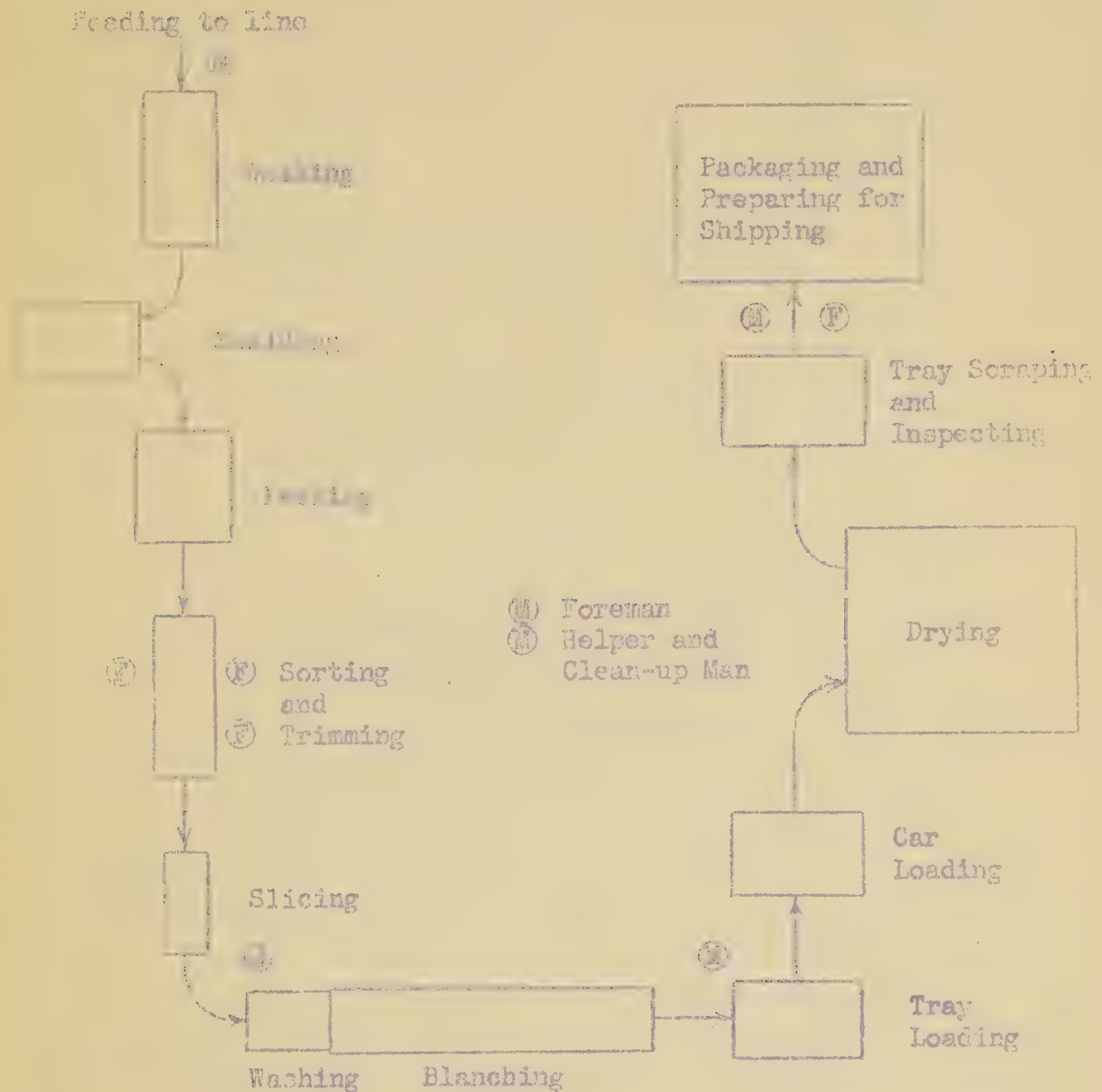
Prepared by the Dehydration Committee,  
 Bureau of Agricultural Chemistry and  
 Engineering, United States Department  
 of Agriculture, August 1942.



# DEHYDRATION FLOW SHEET

400 Pounds per Hour

Unprepared Basis



Labor estimate per shift:

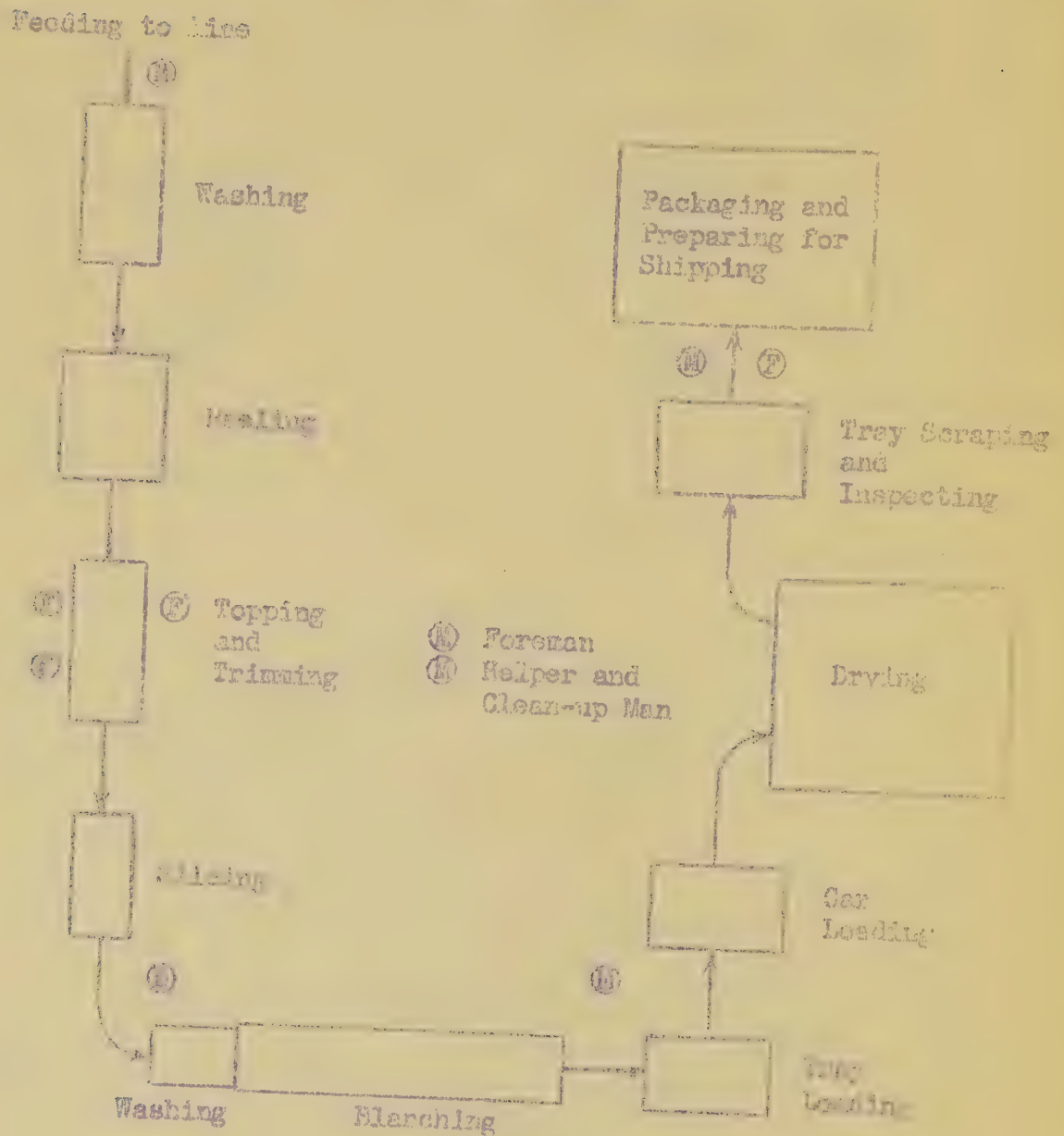
Foremen	-	1
Men	-	5
Women	-	4

Prepared by the Dehydration Committee,  
Bureau of Agricultural Chemistry and  
Engineering, United States Department  
of Agriculture, August 1942.

# DEHYDRATION FLOW SHEET

400 Pounds per Hour

Unprepared Basis



Labor estimate per shift:

Foreman - 1  
 Men - 5  
 Women - 4

Prepared by the Dehydration Committee,  
 Bureau of Agricultural Chemistry and  
 Engineering, United States Department  
 of Agriculture, Aug 31 1941

If further detailed information is  
desired, inquiries should be addressed  
to:

The Dehydration Committee  
Bureau of Agricultural Chemistry  
and Engineering  
U. S. Department of Agriculture  
Washington, D. C.

or to

The Dehydration Committee  
Bureau of Agricultural Chemistry  
and Engineering  
U. S. Department of Agriculture  
800 Buchanan Street  
Albany, California

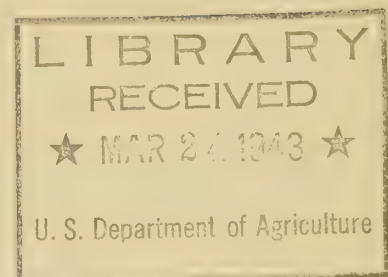




Dehydration Committee  
Bureau of Agricultural Chemistry and Engineering  
U. S. Department of Agriculture

ESTIMATES OF EQUIPMENT COSTS AND LABOR REQUIREMENTS  
IN  
VEGETABLE DEHYDRATION

Plant Capacity--330 Pounds Per Hour  
(Unprepared Basis)



10711

Preparation, final inspection and packaging equipment are the only types of equipment considered in this report. All labor requirements except clerical and shipping are included.

August 1942





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and Labor Requirements  
Vegetable Dehydration at a Plant Capacity of 800 Pounds per Hour,  
Unprepared Basis

This discussion deals with preparation and packaging equipment costs and labor requirements in dehydration plants capable of handling 800 pounds per hour, unprepared basis. It is apparent that the tonnage handled is directly proportional to the length of the operating day. The same preparation equipment is, therefore, required in a batch type plant of 5 tons daily capacity, if the preparation line operates only twelve hours per day, as in a continuous plant of 10 tons daily capacity. The vegetables considered are:

Table Beets  
Cabbage

Carrots  
Onions  
Potatoes

Sweet Potatoes (Yams)  
Turnips (Fartabegs)

Costs of equipment and labor for vegetable drying are subject to wide variation. The ability to improvise certain items may permit substantial savings in plant investment as compared to a plant using standard cannery equipment. Proper plant layout may even eliminate some items. The balance between labor and machinery is a very important factor. The initial cost of a labor-saving machine may be large, but the labor cost saved may be much larger than capital and operating charges on the machine. Relative availability of labor and machinery may determine the proportion of labor and machine operation in a plant.

Equipment listed herein and indicated methods of operation are intended to be merely suggestive. Other items of equipment as well as other operating procedures may be equally satisfactory or even better. For instance, mechanical abrasive peelers have been assumed. Lye peeling, if permitted, by purchase specifications, may be preferable on carrots, potatoes, and other hard root vegetables. Other peeling methods, for example, carbonization by flame or radiant heat, followed by vigorous scrubbing, have also shown promise on an experimental basis. Carrots, turnips, and beets are shown as being peeled before topping. Under certain conditions it may be advisable to do the topping before peeling and the trimming after peeling. Standard mechanical peelers have not proven entirely satisfactory on onions. Operators have adopted various expedients to overcome this difficulty.

Costs and descriptions of equipment are based upon prices and information established manufacturers in this field. The labor set-ups shown are based upon cannery operations and the operations of present commercial dehydrators. They will vary appreciably from plant to plant. If the items of equipment or sequence and methods of operations are different from those given here, the labor set-up



must be modified accordingly.

The accompanying tables show only major items of equipment needed in the preparation of vegetables for drying and in the final inspection and packaging of the dried product. It is assumed that other items of equipment such as graders and spray washers may be improvised and that items such as elevators and conveying belts will be replaced by trucks and ty tables because of the small size of the plant. Some handling of boxes can be eliminated by placing the batch type peeler either above the grating table and by providing a discharge chute from the peeler to the table. The washer may be emptied into the peeler in a similar manner.

Many peelers have the tendency to over-peel smaller size vegetables and under-peel larger ones. Hence it is preferable to put only one size through the peeler at a time. This involves the use of a grader or sizer or the purchase of pre-graded vegetables. The latter might be particularly expedient in a small plant. A simple slat grader may be built at the plant at a cost which is only a small fraction of the cost of a commercially built grader.

A water spray at the beginning of the blancher belt is quite satisfactory in washing the sliced, sliced, or stripped vegetables. A separate washer to do the same work may cost several hundred dollars. If the washing is done, the services of another employee may be required. Such a water spray at the front end of a blancher belt tends to prevent excessive humidity in the preparation room by condensing steam escaping from this end of the blancher.

The amount of steam necessary for blanching will vary from plant to plant depending upon losses from the blancher and care in the avoidance of steam leakage. The range may be from 1 to 3 boiler horsepower for each ton of unprepared vegetables handled per 24-hour period. Except for beets and sweet potatoes, a requirement of 2 boiler horsepower per ton per day has been assumed. Due to retort blanching used for beets, a slightly larger amount is considered necessary. Sweet potatoes are cooked as well as blanched. Due to this double heating, they require somewhat more steam capacity. The plant operator can lessen the investment in steam boilers by insuring proper plant operation to minimize the steam losses and by operating the steam boiler above its rated capacity.

No provision for waste disposal equipment has been made in these estimated costs. Since disposal of waste is a very important and sometimes costly factor, it cannot be overlooked in setting up a plant. Each plant may have its own methods of waste disposal, but it is probable that in the case of potatoes and sweet potatoes, the most common method will involve carrying of wastes from the plant by water. This will necessitate a method of separating suspended solids from the water by screening, settling, or otherwise. These solids may be dried



away, incinerated, or processed for byproduct values. The liquid effluent may be run into a stream, a running stream, or be other placed of disposal. Solid vegetable wastes may be hauled away, burned, or treated for byproduct recovery, but will usually involve a less serious sewerage problem. Some of these methods will be subject to sanitary regulations. Due to the very figures involved, no attempt is being made at this time to show the cost of such equipment. Economical disposal of preparation wastes will usually require some ingenuity on the part of plant operators.

The cost of packaging equipment is based on the assumed use of 5-gallon cans. Recent practice has been to solder the top after filling the can with inert gas. A regulator valve for the gas, relatively inexpensive soldering equipment, and scales are the main items needed for this type of packaging. Other types of packaging might involve a larger capital investment. Automatic can sealers have been recently introduced. These use a plastic sealing material under the edge of the lid which eliminates the necessity for soldering. No increased capital investment is ordinarily involved in the use of the automatic can sealer since the machines are leased to the user. In a small plant such as the one considered here, it is questionable if the use of such a can sealer could be economically justified on the basis of cost alone.

Only one form of prepared vegetable has been considered. Preparation of vegetables in other forms will necessitate the installation of other types of machinery and will usually entail an increase in cost. The labor set-up may also be affected to some extent by resulting differences in blancher loading, tray loading, and drying time.

It is estimated that installation costs will amount to from 10 to 30% of the purchase price of the machinery. Valves, piping, wiring, tanks, hoses, scales, tools, and other accessory equipment plus some allowance for improvised items may amount to an additional 30 to 40%. Together these make a total of about 50% to be added to the purchase price to cover costs of installation and accessory items.

In placing the prepared material on the trays for drying and also in spreading the material on the blancher belt, it is necessary to have it spread uniformly over the surface. This allows for proper air circulation and avoids lumps which may not dry. In blanching, a uniform spread insures adequate penetration of heat to all places of the vegetable. An automatic device for doing this spreading will reduce the number of employees needed at these points.

The number of women that are employed on the sorting and trimming tables will have a marked effect on the operation of the plant. As the number of women increases, more time will be spent on each point of or other vegetable, thus reducing waste and insuring a better final product. Careful sorting and trimming will decrease the amount of blemished material discarded in the final inspection, decrease the likelihood of product rejection, and probably decrease the number of employees needed for the final inspection. There will, however, be an optimum

point for the most economical operation of the plant in obtaining an acceptable product.

It is assumed that the work men shown in the accompanying process will assist in actual processing of the material, in care and operation of the equipment, and in removal of waste from the mixer. It has not been indicated on the flowcharts if a man performs more than one operation. Due to the small size of plant, many of the employees will have to do several operations in order to utilize their time most efficiently.

Since actual working time in an 8-hour shift may be only 7 hours, the indicated hourly capacities are only intended to be an average of quantities handled during an 8-hour shift. Quantities handled in any one hour of actual operation will have to be slightly higher if the assumed rate of production is to be maintained throughout a complete shift. The number of employees indicated should as a rule be sufficient to cover this difference.



# SUMMARY OF COSTS

Preparation, Final Inspection, and Packaging Equipment,  
and Labor Requirements in  
Vegetable Dehydration at a Plant Capacity of 830 Pounds per Hour

Unprepared Basis

Name of Vegetable	Shrinkage Ratio	Equipment Cost			Labor Cost	
		Total	Per Ton 1/		Per Pound	
			Wet : (Unpre- pared):	Dry	Wet : (unpre- pared):	Dry
		\$	\$	\$	\$	\$
Table Beets	13 to 1	3,763.	377.	4,895.	1.48	39.3
Carrots	19 to 1	4,065.	407.	7,724.	1.31	24.6
Onions	10 to 1	4,440	444.	4,440	1.46	21.6
Peas	14 to 1	2,640.	264.	3,696.	1.13	15.5
Peas	7 to 1	5,265	537.	4,106.	1.80	12.9
Sweet Potatoes	4 1/2 to 1	5,115	512	2,302.	1.60	7.8
Turnips	10 to 1	4,440.	444.	4,440.	1.45	25.3

1/ Equipment cost per ton handled per 24-hour day.

Capacities per Unit of Time  
In a Vegetable Dehydration Plant  
Capable of Handling 830 Pounds per Hour

(Unprepared Basis)

	Beets	Cabbage	Carrots	Onions	Potatoes	Sweet Potatoes (Yams)	Turnips
<u>Form Prepared</u>	Slices	Shreds	Slices	Slices	Strips	Slices	Slices
<u>Unprepared basis:</u>							
Tons per 24-hour day	10	10	10	10	10	10	10
Pounds per 24-hour day	20,000	20,000	20,000	20,000	20,000	20,000	20,000
Pounds per hour	830	830	830	830	830	830	830
Pounds per minute	14	14	14	14	14	14	14
No. of women coring		2					
Pounds per woman per hour		415					
Pounds per woman per minute		6.9					
Number of retorts	2						
Blanching time in minutes	10						
Minutes per charge per retort - loading, blanching & unloading	20						
Charges per hour	6						
Pounds per charge	140						
Cars or crates per charge	3						
Pounds per car or crate	46						
<u>Prepared basis:</u>							
Assumed preparation loss	30%	25%	25%	15%	25%	25%	25%
Tons per 24-hour day	7.0	7.5	7.5	8.5	7.5	7.5	8.0
Pounds per 24-hour day	14,000	15,000	15,000	17,000	15,000	15,000	16,000
Pounds per hour	580	620	620	710	630	620	670
Pounds per minute	9.7	10.3	10.3	11.8	10.5	10.3	11.2
Number of women sorting, topping and trimming	5		5	4	10	6	5
Pounds per woman per hour	115		125	175	65	105	135
Pounds per woman per minute	1.9		2.1	3.0	1.0	1.7	2.2
Assumed blancher loading - lbs. per square foot		1.3	2.0		2.0	2.0	2.0
Assumed blanching time in minutes		3	4		4	6	4
Pounds in blancher at any one time		31	42		42	63	44
Square feet of blancher needed		21	21		21	32	22
Assumed try loading - lbs. per square foot	1.5	1.2	1.5	1.2	1.5	1.5	1.5
Pounds per car	590	455	590	475	590	590	590

Capacities per Unit of Time  
In a Vegetable Dehydration Plant  
Capacities of Processing All Vegetables per Hour (cont'd)

(Unprepared Basis)

	Beets	Cabbage	Carrots	Onions	Potatoes	Sweet Potatoes (Yams)	Turnips
<u>Prepared</u>	Slices	Shreds	Slices	Slices	Strips	Slices	Slices
24-hour day	24	32	25	36	25	25	27
per hour	1.0	1.3	1.0	1.5	1.0	1.0	1.1
per minute	61	45	57	40	57	57	53
per hour	22	22	22	22	22	22	22
per minute	27	21.6	27	21.6	27	27	27
24-hour day	520	690	560	790	560	560	590
per hour	22	29	23	33	23	23	25
per minute	0.37	0.48	0.38	0.55	0.38	0.38	0.4
per hour	160	125	160	110	160	160	145
<u>Shrinkage</u>							
estimated overall shrinkage ratio	13 to 1	19 to 1	10 to 1	14 to 1	7 to 1	4½ to 1	10 to 1
24-hour day	1,540	1,010	2,000	1,430	2,860	4,440	2,000
per hour	65	45	85	60	120	185	85
per minute	1.1	0.73	1.4	1.0	2.0	3.1	1.4
5-gallon can	10	5	14	9	10	13	6
24-hour day	155	210	140	160	265	340	335
per hour	6.5	8.3	5.8	6.7	11.9	14.2	14.0
minutes per can	9.2	6.8	10.3	9.0	5.0	4.2	4.3



TABLE BEEBIS  
Preparation, Final Inspection and Packaging Equipment, and  
Labor Requirements  
In a Dehydration Plant Capable of Handling 830 Pounds per Hour

Unprepared Basis

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>
Feeding to Preparation Line		
Washing	Rotary bar washer Drum size - 25" x 6' With 1 h.p. motor	\$ 450.
Blanching - 10 minutes at 5 pounds pressure in retorts	2 Small retorts with 3 crates each with pulleys and hoists	700.
Peeling	Batch peeler With 1½ h.p. motor	600.
Topping and Trimming	Table - 3' x 10'	75.
Washing	Vat or trough	50.
Slicing	Slicer With ½ h.p. motor	475.
Tray Loading and Stacking	Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below.	
Moving Cans and Drying		
Scraping Trays	Table top over bin	100.
Final Inspecting	Inspection done by employees scraping trays.	
Packaging and Preparing for Shipping	Scales, table, and sealing equipment	100.
General - Foreman Helpers, cleanup, washing trays, and maintenance		
Sub-total		1325.

# TABLE BEETS (continued)

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
Sub-total		\$2,510.	
a 40% for installation and accessory equipment; 50% for same plus improvised items	50%	<u>1,255.</u>	
Total		<u>\$3,765.</u>	
Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis)		\$ 377.	
Labor Cost per Pound - (13 to 1 overall shrinkage ratio)	5 Women @ 60¢ per hour \$3.00 11 Men @ 75¢ " " 8.25 1 Foreman 1.00 \$ 12.25		
(Based on the labor cost per hour)	Labor cost per wet pound (330 lbs)		1.48¢
	Labor cost per dry pound (64 lbs)		19.1 ¢
Steam Generating - Approximate Boiler Horsepower Needed - (2½ b.h.p. per ton per day) For blanching only.	25 b.h.p.		
Approximate Cost of Boiler if operated at Rated Capacity		\$2,500.	

CABBAGE  
Preparation, Final Inspection and Packaging Equipment, and  
Labor Requirements  
In a Dehydration Plant Capable of Handling 830 Pounds per Hour

Unprepared Basis

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	
Feeding to Preparation Line	Equipment for feeding to the line will probably have to be improv- vised for this size plant	\$ 500.	1
Trimming and Coring	Table - 3' x 6' 2 Improvised cabbage corers With $\frac{1}{2}$ h.p. motor Located over table	50. 125.	2
Washing	Rotary bar washer Drum size - 25" x 6" With 1 h.p. motor	450.	
Shredding	Kraut cutter 21" disc With $\frac{1}{2}$ h.p. motor	225.	
Spreading on Blancher Belt			1
Blanching, 3 Minutes - Loading on blancher belt, $1\frac{1}{2}$ pounds per square foot	Wire belt blancher Overall length - 18' Covered area - 24" x 11' With 1 h.p. motor	1,200	
Tray Loading and Stacking	Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below.		
Moving Cars and Drying			
Scraping Trays	Table top over bin	100.	2
Final Inspecting	Inspection done by employees scraping trays.		
Packaging and Preparing for Shipping	Scales, table, and sealing equipment		



# CABBAGE (continued)

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
General - Foreman			1 M
Helpers, cleanup, washing trays, and maintenance			2 M
Sub-total		\$2,710.	
Add 40% for installation and accessory equipment; 50% for same plus improvised items	50%	1,355.	
Total		\$4,065	
Equipment Cost per Ton Handled per 24-hour Day (Unprepared Basis)		\$ 407.	
Labor Cost per Pound -	4 Women @ 60¢ per hour \$ 2.40		
(12 to 1 overall shrinkage ratio)	10 Men @ 75¢ " " 7.50		
(Based on the labor cost per hour)	1 Foreman 1.00	10.90	
	Labor cost per wet pound (830 lbs)		1.31¢
	Labor cost per dry pound (44 lbs)		24.8 ¢
Steam Generating - Approximate Boiler Horsepower Needed - (2 b.h.p. per ton per day) For blanching only.	20 b.h.p.		
Approximate Cost of Boiler if Operated at Rated Capacity		\$2,100.	

# CARROTS

Preparation, Final Inspection and Packaging Equipment, and  
Labor Requirements  
For a Preparation Plant Capable of Handling 100 Pounds per Hour

## Unprepared Basis

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
Feeding to Preparation Line			1 M
Washing	Rotary bar washer Drum size - 25" x 6' With 1 h.p. motor	\$ 450.	
Peeling	Batch peeler With 1½ h.p. motor	600.	
Topping and Trimming	Table - 3' x 10'	75.	5 F
Slicing	Slicer With ½ h.p. motor	475.	1 M
Spreading on Blancher Belt			1 F
Washing	Sprays on front end of blancher. Included in blancher cost.		
Blanching, 4 Minutes - Loading on blancher belt, two pounds per square foot.	Wire belt blancher Overall length - 18' Covered area - 24" x 11' With 1 h.p. motor	1,200.	
Trey Loading and Stacking	Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below.		2 M
Moving Cars and Drying			1 M
Scraping Trays	Table top over bin	100.	2 M
Final Inspecting	Inspection done by employees scraping trays.		
Packaging and Preparing for Shipping	Scales, table, and sealing equipment	60.	1 M

# CARROTS (continued)

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Lab</u>
General - Foreman			1
Helpers, cleanup, tray			2
washing, and maintenance			
Sub-total		\$2,960	
Add 40% for installation and accessory equipment; 50% for same plus improvised items.	50%	1,480.	
Total		<u>\$4,440.</u>	
Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis)		<u>\$ 644.</u>	
Labor Cost per Pound - (10 to 1 overall shrinkage ratio) (Based on the labor cost per hour)	6 Women @ 60¢ per hour \$ 3.60 10 Men @ 75¢ " " 7.50 1 Foreman 1.00 Labor cost per wet pound (830 lbs) Labor cost per dry pound (83 lbs)	<u>12.10</u>   14.6¢	
Steam Generating - Approximate Boiler Horsepower Needed - (22 h.p. per ton per day) For blanching only. Approximate Cost of Boiler if Operated at Rated Capacity	20 b.h.p.	\$2,100.	



ONIONS

Preparation, Final Inspection and Packaging Equipment, and  
Labor Requirements  
In a Dehydration Plant Capable of Handling 830 Pounds per Hour

Unprepared Basis

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
Feeding to Preparation Line			1 M
Peeling	Batch peeler With 1½ h.p. motor	\$ 600.	
Sorting and Trimming	Table - 3' x 10'	75.	4 F
Washing	Rotary bar washer Drum size - 25" x 6" With 1 h.p. motor	450.	
Slicing	Slicer With ½ h.p. motor	475.	
Tray Loading and Stacking	Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below.		2 M
Moving Cars and Drying			1 M
Scraping Trays	Table top over bin	100.	2 M
Final Inspecting	Inspection done by employees scrapping trays.		
Packaging and Preparing for Shipping	Scales, table, and sealing equipment	60.	1 M
General - Foreman			1 M
Helpers, cleanup, washing trays, and maintenance			1 M
Sub-total		\$1,760.	
Add 40% for installation and accessory equipment; 50% for same plus improvised items	50%	880.	
Total		\$2,640.	

# ONIONS (continued)

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>
Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis)		\$ <u>264.</u>
Labor Cost per Pound -- (14 to 1 overall shrinkage)	4 Women @ 60¢ per hour \$ 2.40 8 Men @ 75¢ " " 6.00 1 Foreman 1.00	<u>\$ 9.40</u>
(Based on the labor cost per hour)	Labor cost per wet pound (830 lbs)	1.13¢
	Labor cost per dry pound (59 lbs)	15.9 ¢

# POTATOES

Preparation, Final Inspection and Packaging Equipment, and  
Labor Requirements  
In a Dehydration Plant Capable of Handling 830 Pounds per Hour

## Unprepared Basis

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
Feeding to Preparation Line			1 M
Washing	Rotary bar washer Drum size - 25" x 6' With 1 h.p. motor	\$ 450.	
	It would be advisable to buy pregraded potatoes		
	Batch peeler With 1½ h.p. motor	600.	
Sorting and Trimming	Belt conveying sorter Belt size - 30" x 15' With 1 h.p. motor	800.	10 F
	Strip cutter and slicer With 2 h.p. motor	700.	
Spreading on Blancher Belt			1 F
Washing	Sprays on front end of blancher - Included in blancher cost.		
Blanching, 4 Minutes - Loading on blancher belt, two pounds per square foot.	Wire belt blancher Overall length - 18' Covered area - 24" x 11' With 1 h.p. motor	1,200.	
Tray Loading and Stacking	Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equip- ment. See below.		2 M
Moving Cars and Drying			1 M
Scraping Trays	Table top over bin	100.	2 M
Final Inspecting	Inspection done by employees scraping trays.		



- 1 -  
POTATOES (continued)

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	
Packaging and Preparing for Shipping	Scales, table, and sealing equipment	\$ 60.	1
General - Foreman			1
Helpers, cleanup, washing trays, and maintenance			2
Sub-total		\$3,910.	
Add 40% for installation and accessory equipment; 50% for same plus improvised items.	50%	<u>1,955.</u>	
Total		<u>\$5,865.</u>	
Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis)		<u>\$ 587.</u>	
Labor Cost per Pound -	12 Women @ 60¢ per hour	\$ 7.20	
(7 to 1 overall shrinkage ratio)	9 Men @ 75¢ " "	6.75	
(Based on the labor cost per hour)	1 Foreman	<u>1.00</u>	\$ 1.95
	Labor cost per wet pound (830 lbs)		1.80¢
	Labor cost per dry pound (120 lbs)		12.5 ¢
Steam Generating - Approximate Boiler Horsepower Needed - (2 b.h.p. per ton per day) for blanching only.	20 b.h.p.		
Approximate Cost of Boiler if Operated at Rated Capacity		\$2,100.	

SWEET POTATOES  
Preparation, Final Inspection and Packaging Equipment, and  
Labor Requirements  
In a Dehydration Plant Capable of Handling 830 Pounds per Hour

Unprepared Basis

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
Feeding to Preparation Line			1 M
Washing	Rotary bar washer Drum size - 25" x 6' With 1 h.p. motor	\$ 450.	
Scalding, 10 Minutes in Boiling Water	Wooden vat with steam pipes, hoist, etc.	250.	
Peeling	Batch peeler With 1½ h.p. motor	600.	1 M
Sorting and Trimming	Table - 3' x 10'	75.	6 F
Slicing	Slicer With ½ h.p. motor	475.	
Spreading on Blancher Belt			1 F
Washing	Sprays on front end of blancher - Included in blancher cost.		
Blanching, 6 Minutes - Loading on blancher belt, two pounds per square foot.	Wire belt blancher Overall length - 24' Covered area - 24" x 16' With 1 h.p. motor	1,400.	
Tray Loading and Stacking	Rollers, scales, and other loading equipment are small items, being included as accessory equipment.		2 M
Moving Cars and Drying			1 M
Scraping Trays	Table top over bin	100.	2 M
Final Inspecting	Inspection done by employees scraping trays.		

SWEET POTATOES (continued)

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
Packaging and Preparing for Shipping	Scales, table, and sealing equipment	\$ 60.	1 1/2
General - Foreman			1 1/2
Helpers, cleanup, washing trays, and maintenance			3 1/2
Sub-total		\$3,410.	
Add 40% for installation and accessory equipment; 50% for same plus improvised items.		50% 1,705.	
Total		<u>\$5,115.</u>	
Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis)		<u>\$ 512.</u>	
Labor Cost per Pound	8 Women @ 60¢ per hour \$ 4.80		
(4 1/2 to 1 overall shrinkage ratio)	10 Men @ 75¢ " " 7.50		
(Based on the labor cost per hour)	1 Foreman 1.00	\$ 13.30	
	Labor cost per wet pound (830 lbs)		1.60
	Labor cost per dry pound (185 lbs)		7.20
Steam Generating - Approximate Boiler Horsepower Needed - (3 b. h.p. per ton per day) For scalding and blanching only.		30 b.h.p.	
Approximate Cost of Boiler if Operated at Rated Capacity		\$2,900.	



# TURNIPS

Preparation, Final Inspection and Packaging Equipment, and  
Labor Requirements  
In a Dehydration Plant Capable of Handling 830 Pounds per Hour

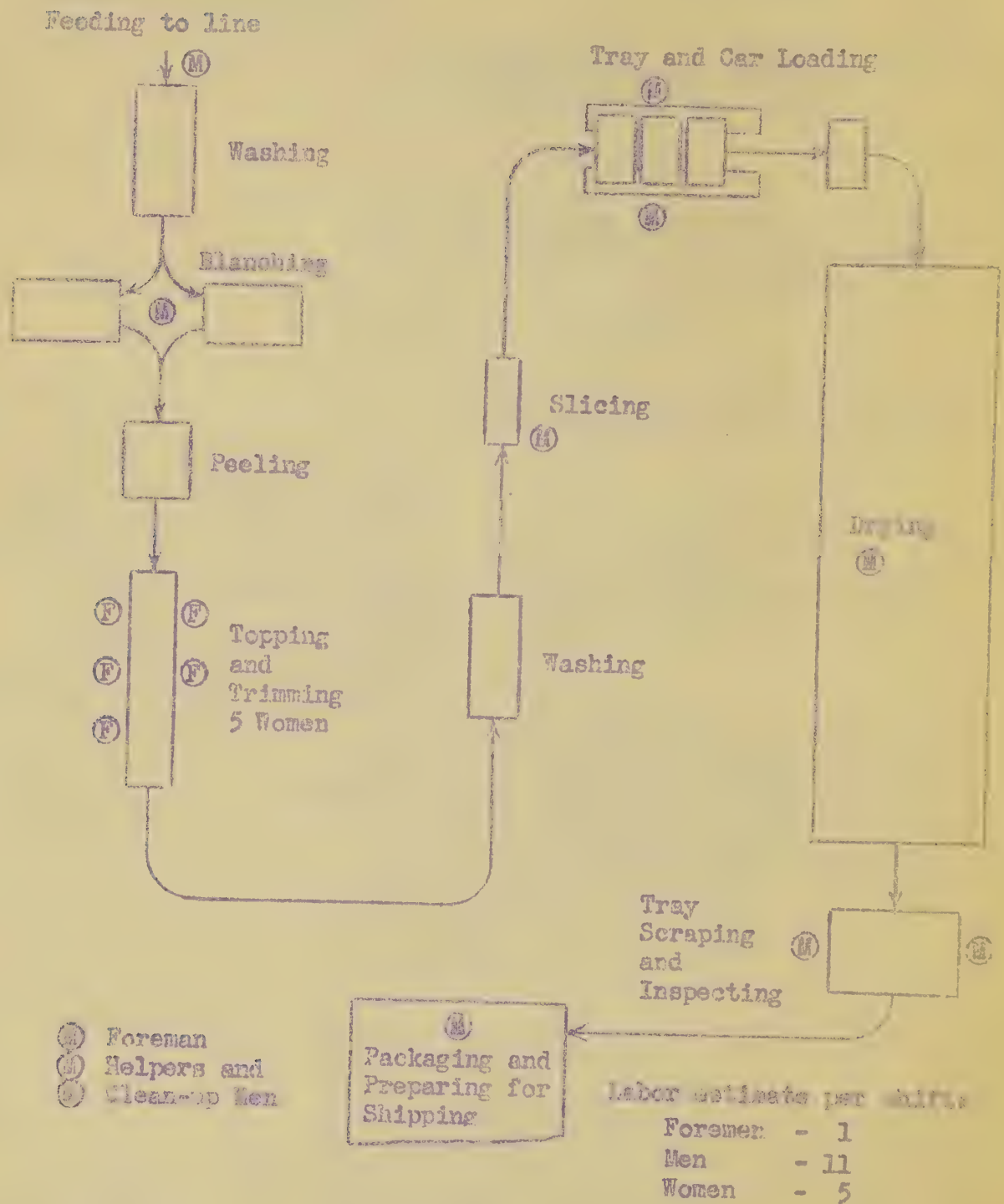
Unprepared Basis

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
Feeding to Preparation Line			1 M
Washing	Rotary bar washer Drum size - 25" x 6' With 1 h.p. motor	\$ 450.	
Peeling	Batch peeler With 1½ h.p. motor	600.	
Topping and Trimming	Table - 3' x 10'	75.	5 F
Slicing	Slicer With ½ h.p. motor	475.	1 M
Spreading on Blancher Belt			1 F
Washing	Sprays on front end of blancher - Included in blancher cost		
Blanching, 4 Minutes - Loading on blancher belt, two pounds per square foot.	Wire belt blancher Overall length - 18' Covered area - 24" x 11' With 1 h.p. motor	1,200.	
Tray Loading and Stacking	Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below.		2 M
Moving Cars and Drying			1 M
Scraping Trays	Table top over bin	100.	2 M
Final Inspecting	Inspection done by employees scraping trays.		
Packaging and Preparing for Shipping	Scales, table, and sealing equipment	60.	1 F 1 M

# TURNIPS (continued)

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>
General - Foreman Helpers, cleanup, washing trays, and maintenance		
Sub-total.		\$2,160.
Add 40% for installation and accessory equipment; 50% for same plus improvised items.	50%	1,450.
Total		\$3,610.
Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis)		\$1,114.
Labor Cost per Pound - (10 to 1 overall shrinkage ratio) (Based on the labor cost per hour)	7 Women @ 60¢ per hour \$4.20 10 Men @ 75¢ " " 7.50 1 Foreman 1.00 Labor cost per wet pound (830 lbs) Labor cost per dry pound (83 lbs)	15.70
Steam Generating - Approximate Boiler Horsepower Needed - (2 b.h.p. per ton per day) For blanching only. Approximate Cost of Boiler if Operated at Rated Capacity	20 b.h.p.	\$1,114.

LEMONS  
 DEHYDRATION FLOW SHEET  
 830 Pounds per Hour  
 Unprepared Basis

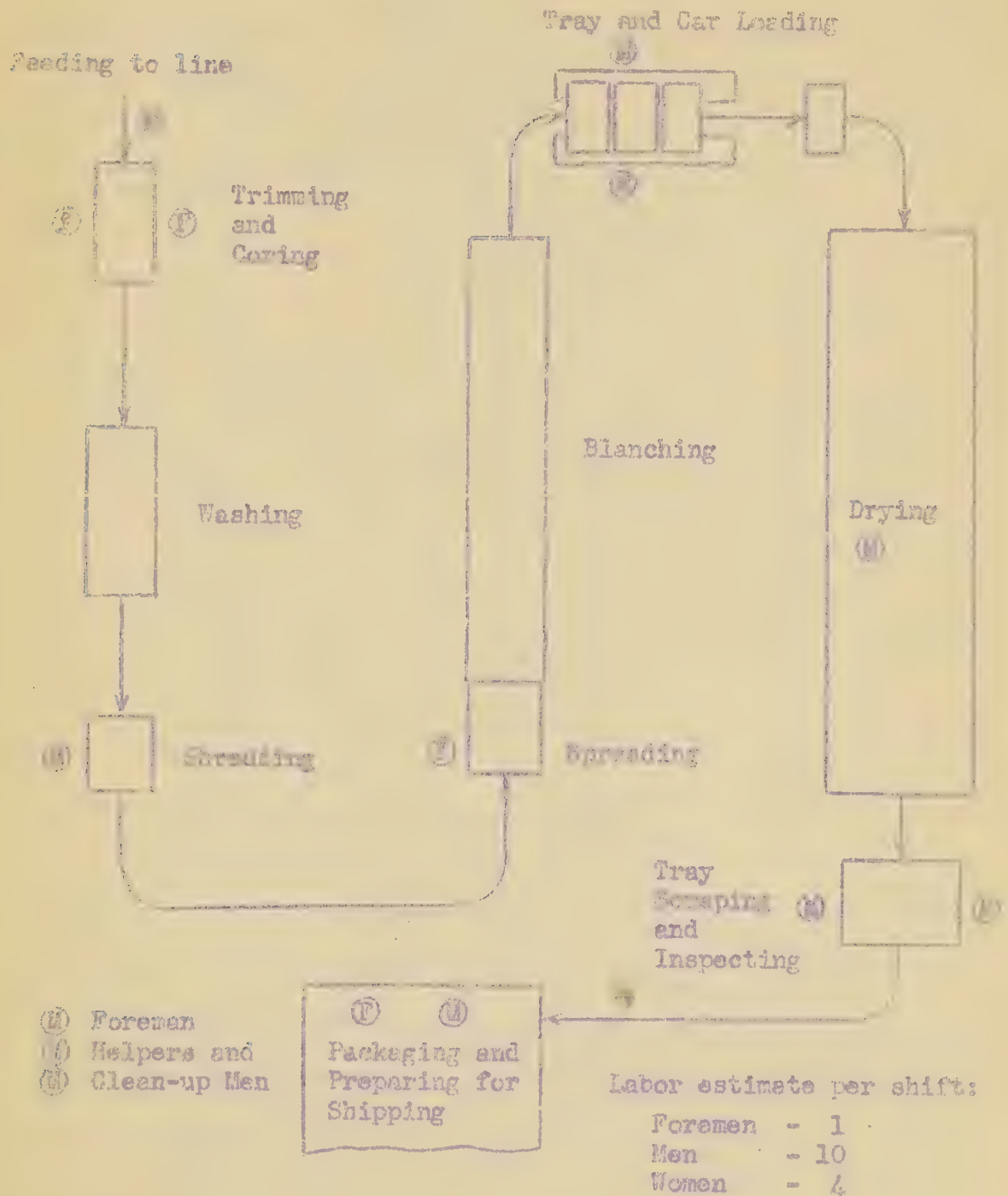




# DEHYDRATION FLOW CHART

830 Pounds per Hour

Unprepared Basis

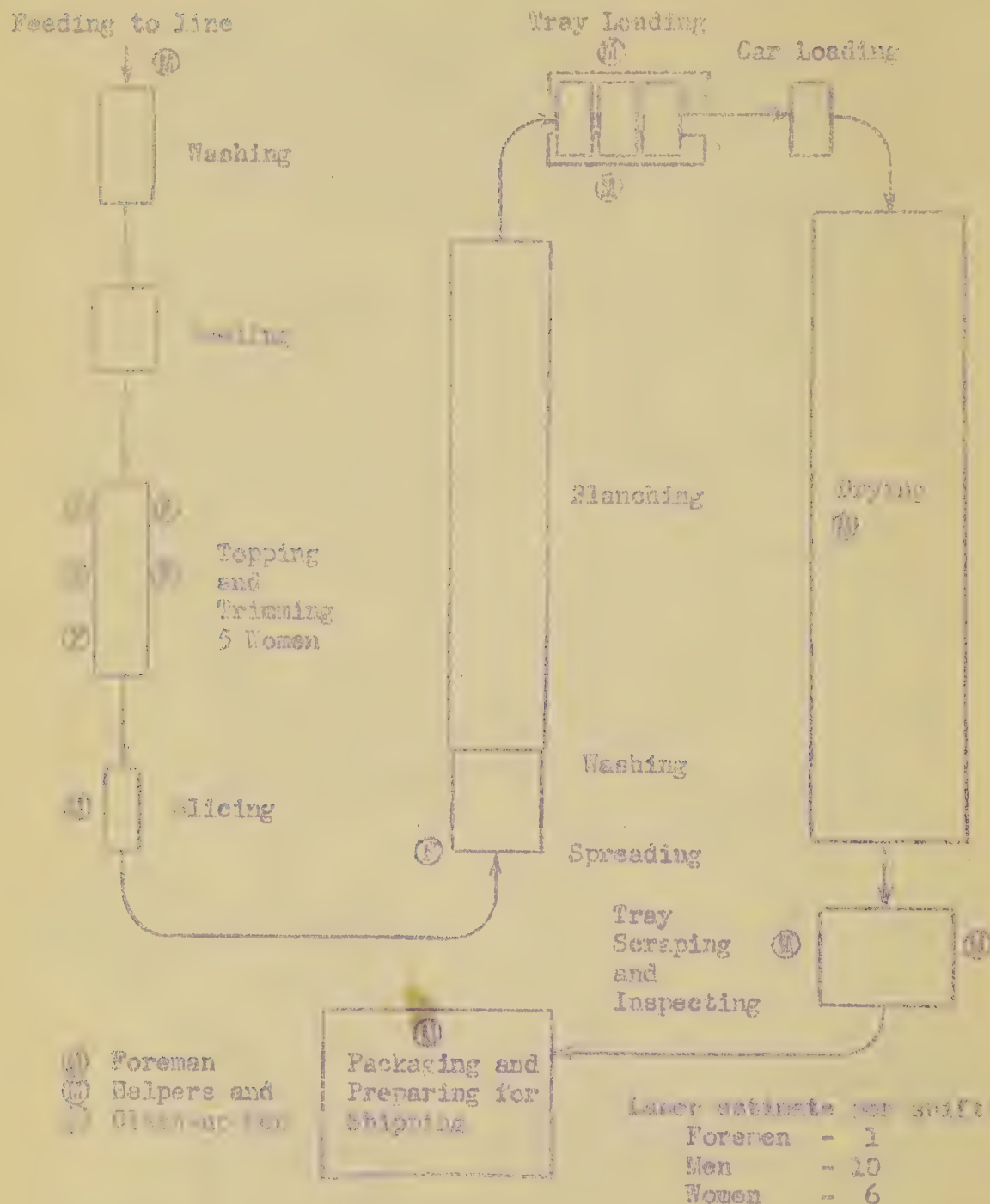


# CARROTS

## DEHYDRATION FLOW SHEET

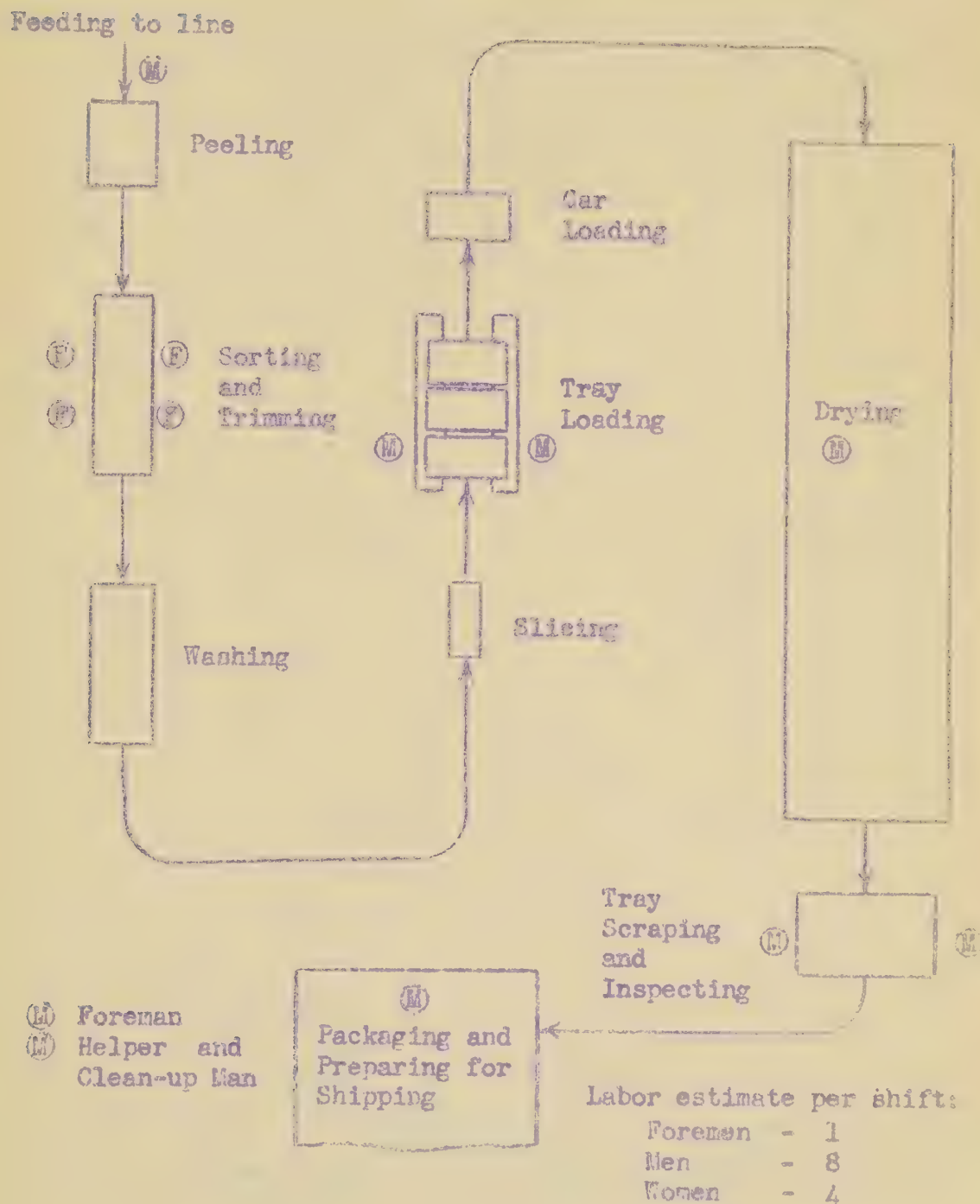
830 Pounds per Hour

Unprepared Basis



Prepared by the Dehydration Committee,  
Bureau of Agricultural Chemistry and  
Engineering, United States Department  
of Agriculture, August 1942.

ONIONS  
DEHYDRATION FLOW SHEET  
830 Pounds per Hour  
Unprepared Basis

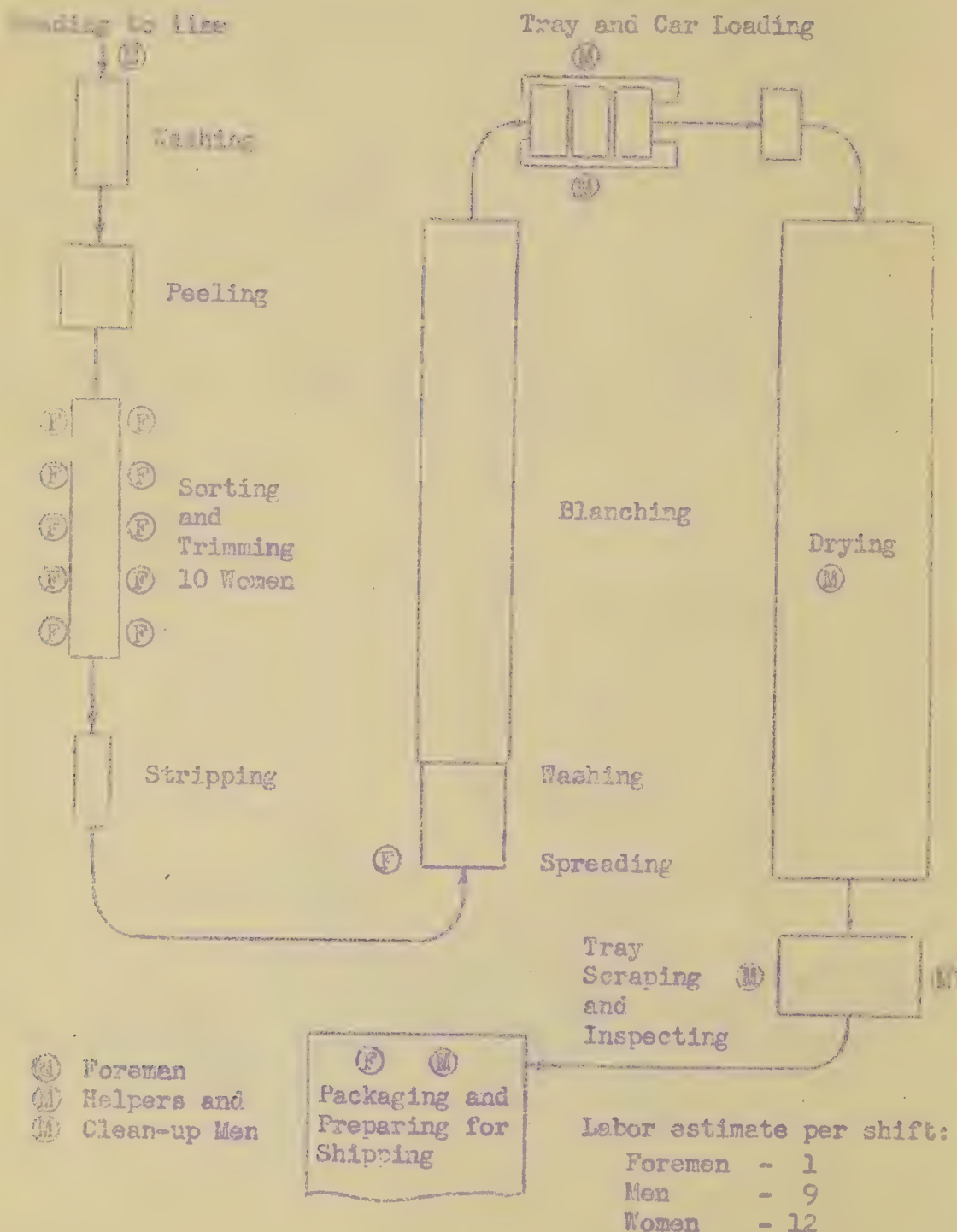




POTATOES  
DEHYDRATION FLOW SHEET

830 Pounds per Hour

Unprepared Basis

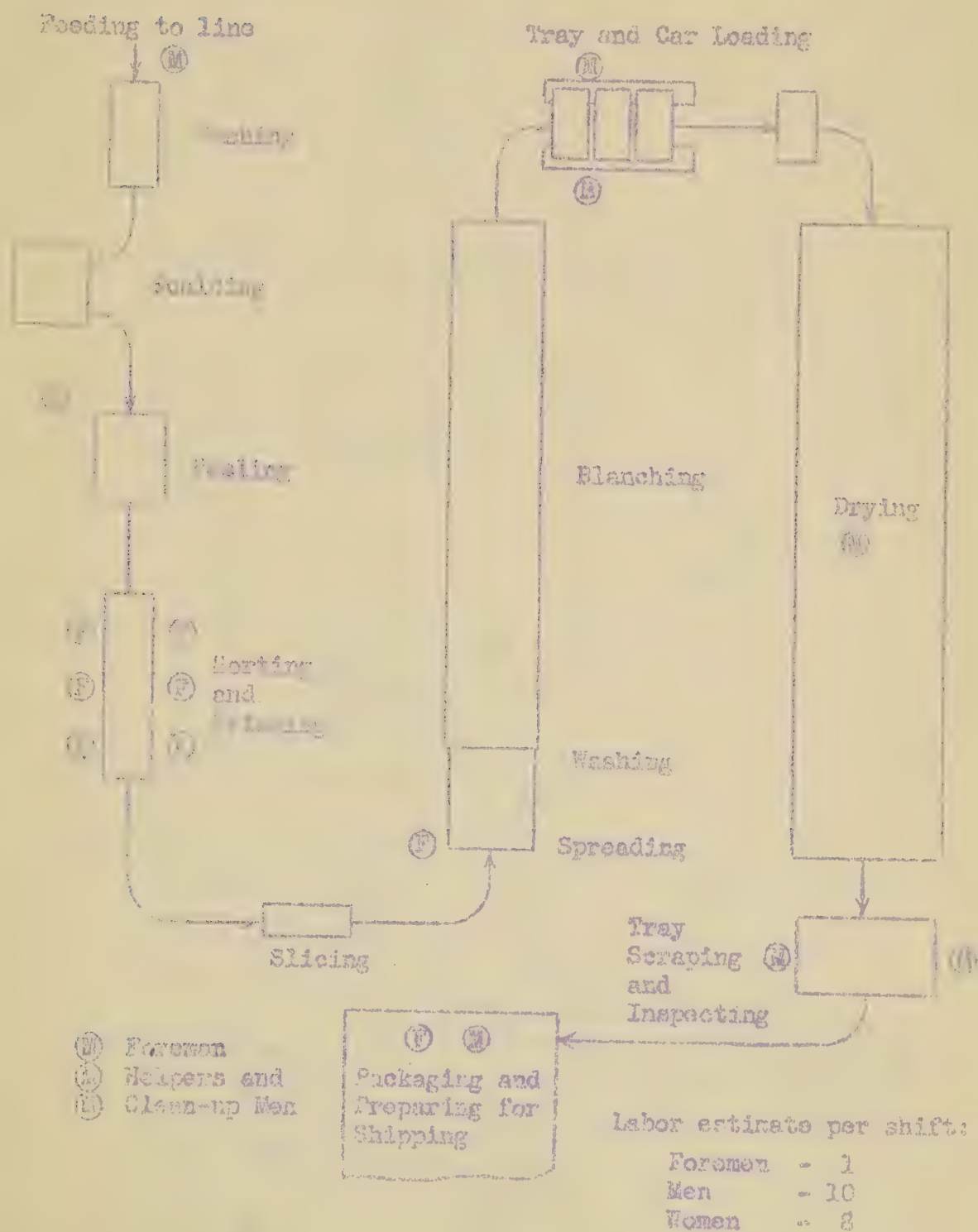


Prepared by the Dehydration Committee,  
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Engineering, United States Department  
of Agriculture, August 1942.

# LEGNITRATION WORK SHEET

850 Pounds per Hour

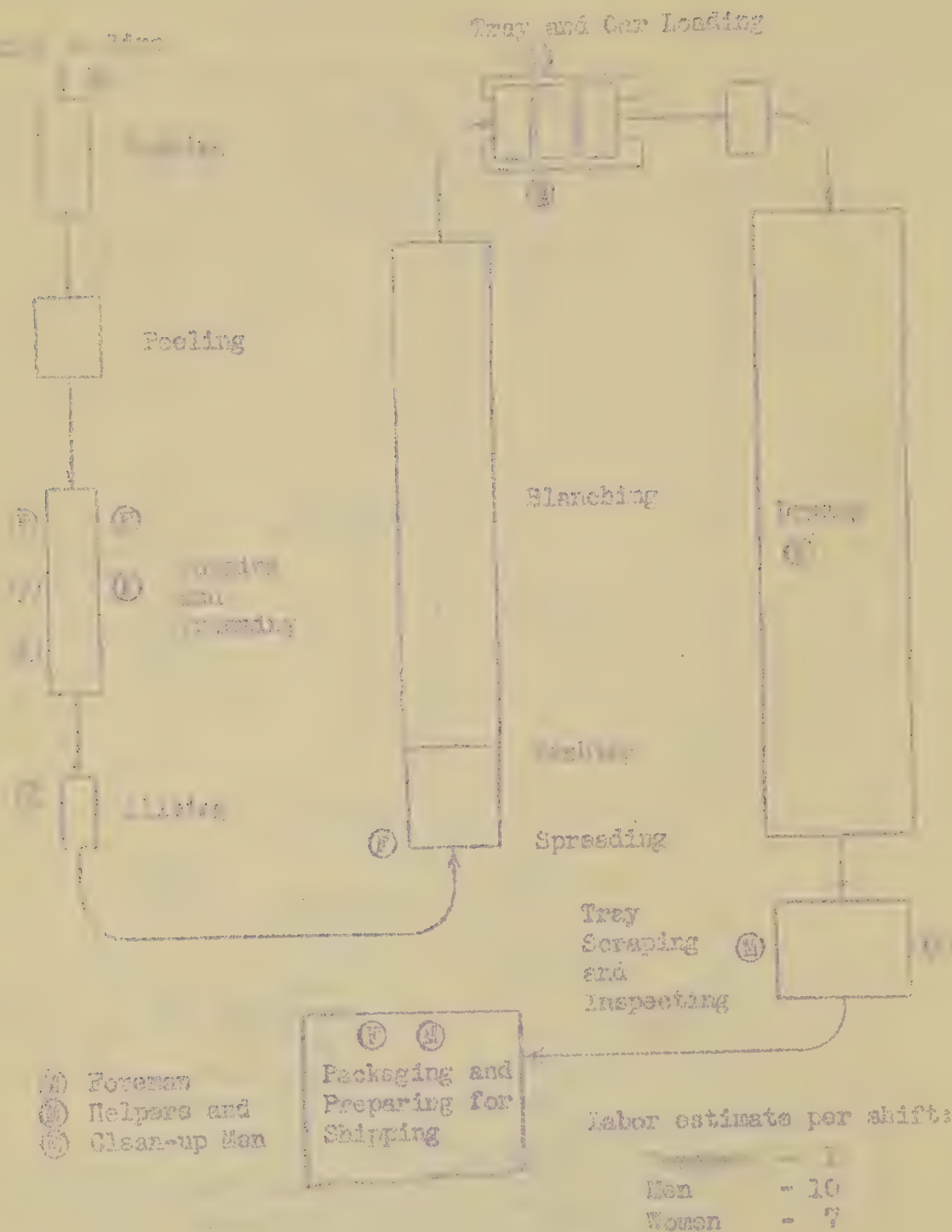
Unprepared Basis



Prepared by the Dehydration Committee,  
Bureau of Agricultural Chemistry and  
Engineering, United States Department  
of Agriculture, August 1942

# DEHYDRATION FLOW SHEET

250 Pounds per Hour  
Unprepared Basis



Prepared by the Dehydration Committee,  
Bureau of Agricultural Chemistry and  
Engineering, United States Department  
of Agriculture, August 1942.



If further detailed information is  
desired, inquiries should be addressed  
to:

The Hydrogen Committee  
Bureau of Aeronautics  
and Engineering  
U. S. Department of War  
Washington, D. C.

or

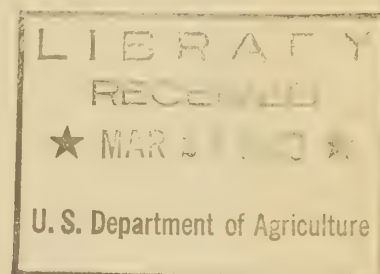
The Oxygen Committee  
Bureau of Aeronautics  
and Engineering  
U. S. Department of War  
333 Buchanan Street  
Albany, California



Bureau of Agricultural Chemistry and Engineering  
U. S. Department of Agriculture

ESTIMATES OF EQUIPMENT COSTS AND LABOR REQUIREMENTS  
VEGETABLE DEHYDRATION

Plant Capacity--1,670 Pounds Per Hour  
(Unprepared Basis)



Preparation, final inspection and packaging equipment are the only types of equipment considered in this report. All labor requirements except clerical and shipping are included.

August 1942





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Preparation, Final Inspection, and Packaging Equipment,  
and Labor Requirements in  
Vegetable Dehydration at a Plant Capacity of 1,670 Pounds per Hour,  
Unprepared Basis

This discussion deals with the labor requirements and cost of preparation and packaging equipment in dehydration plants capable of handling 1,670 pounds per hour, unprepared basis, or 20 tons per 24-hour day. The vegetables considered are:

Table Beets  
Cabbage

Carrots  
Onions  
Potatoes

Sweet Potatoes (Yams)  
Turnips (Rutabagas)

Costs of equipment and labor for vegetable drying are subject to wide variation. The ability to improvise certain items may permit substantial savings in plant investment as compared to a plant using standard cannery equipment. Proper plant layout may even eliminate some items. The balance between labor and machinery is a very important factor. The initial cost of a labor-saving machine may be large, but the labor cost saved may be much larger than capital and operating charges on the machine. Relative availability of labor and machinery may determine the proportion of labor and machine operation in a plant.

Equipment listed herein and indicated methods of operation are intended to be merely suggestive. Other items of equipment as well as other operating procedures may be equally satisfactory or even better. For instance, mechanical abrasive peelers have been assumed. Lye peeling, if permitted by purchase specifications, may be preferable on carrots, potatoes, and other hard root vegetables. Other peeling methods, for example, carbonization by flames or radiant heat, followed by vigorous scrubbing, have also shown promise on an experimental basis. Carrots, turnips and beets are shown as being peeled before topping. Under certain conditions it may be advisable to do the topping before peeling and the trimming after peeling. Standard abrasive peelers have not proven entirely satisfactory on onions. Operators have adopted various expedients to overcome this difficulty.

Costs and descriptions of equipment are based upon prices and information from established manufacturers in this field. The labor set-ups shown are based upon cannery operation and the operations of present commercial dehydrators. They will vary appreciably from plant to plant. If the items of equipment or sequence and methods of operations are different from those given here, the labor set-up must be modified accordingly.

The accompanying tables show only major items of equipment needed in the preparation of vegetables for drying and in the final inspection



and packaging of the dry product. It is recognized that elevators and conveyors may be major items of cost. They have not been specifically included, except in a special case, because considerable improvement will usually be done by the plant operator in the installation of these items of equipment or in the arrangement of other equipment so as to eliminate the necessity for their use. A part of the allowance for installation and necessary equipment is intended for this purpose.

Some peeler have the tendency to overpeel smaller size vegetables and inadequately peel larger ones. Hence, it is preferable to put only one size through the peeler at a time. This involves the use of a grader or sizer or the purchase of pre-graded vegetables. The latter might be particularly expedient in a small plant. A simple slot grader may be built at the plant at a cost which is only a small fraction of the cost of a commercially built grader.

Water spray at the beginning of the blancher belt is quite satisfactory in washing the diced, sliced, or stripped vegetables. A separate method to do the same work may cost several hundred dollars. Such a water spray at the front end of the blancher belt tends to prevent excessive humidity in the preparation room by condensing steam escaping from this end of the blancher.

The amount of steam necessary for blanching will vary from plant to plant depending upon losses from the blancher and cur in the evaporation of steam waste. The range may be from 1 to 3 boiler horsepower for each ton of unprepared vegetables handled over 24-hour period. Except for beets and sweet potatoes, a requirement of 2 boiler horsepower per ton per day has been assumed. Due to retort blanching used for beets, a slightly larger amount is considered necessary. Sweet potatoes are scalded as well as blanched. Due to this double heating, they require somewhat more steam capacity. The plant operator can lessen the investment in steam boilers by insuring proper plant operation to minimize the steam losses and by operating the steam boiler above its rated capacity.

The line-up provides for little or no stand-by equipment. Where there is a possibility that the stopping of any machine will interrupt the continuous flow of the product through the plant, some means of substitute operation should be available or there should be storage facilities for the product so that it will not deteriorate while standing.

No provision for waste disposal equipment has been made in these estimated costs. Since disposal of waste is a very important and essential part of the plant, it cannot be overlooked in setting up a plant. Each plant may have its own methods of waste disposal, but it is probable that in the case of potatoes and sweet potatoes



the most common method will involve carrying of wastes from the plant by water. This will necessitate a method of separating suspended solids from the water by screening, settling, or otherwise. These solids may be hauled away, incinerated, or processed for byproduct sales. The liquid effluent may be run into a sewer, a running stream, or to other places of disposal. Other vegetable wastes may be hauled away, burned, or treated for byproduct recovery, but will usually involve a less serious sewerage problem. Each of these methods will be subject to sanitary regulation. Due to the many factors involved, no attempt is being made at this time to show the cost of such equipment. Economical disposal of preparation water will usually require some ingenuity on the part of plant operators.

Only one form of prepared vegetable has been considered. Preparation of vegetables in other forms will necessitate the installation of other types of cutters and will usually entail an increase in cost. The labor set-up may also be affected to some extent by resulting differences in blancher loading, tray loading, and drying time.

In the case of onions, at least a portion of the product will usually be converted to a powder form. It is necessary to conduct this operation in a dry atmosphere and special equipment will have to be installed for this purpose. It is advantageous to conduct all onion packing operations in an air-conditioned room maintained at low humidity.

The cost of packaging equipment is based on the assumed use of 5-gallon cans. Present practice has been to solder the top after filling the can with inert gas. A regulator valve for the gas, relatively inexpensive soldering equipment, and scales are the main items needed for this type of packaging. Other types of packaging might involve a larger capital investment. Automatic can sealers have been recently introduced. These use a plastic sealing material under the edge of the lid which eliminates the necessity for soldering. No increased capital investment is ordinarily involved in the use of the automatic can sealer since the machines are leased to the user. Equipment operating costs will be higher due to the rental paid, but these will be more than offset by lower labor costs.

Inspection belts included are straight single-unit belts. Merry-go-round or other divided belts will involve higher equipment costs on the sorting and trimming line. Their use may, however, result in reduced labor costs.

It is estimated that installation costs will amount to from 10 to 20% of the purchase price of the machinery. Valves, piping, wiring, trucks, boxes, scales, tools, and other accessory equipment plus some allowance for improvised items may amount to an additional 30 to 40%. Together these make a total of about 50% to be added to the purchase price to

cover the costs of installation and accessory items.

The number of employees needed to operate a plant is by no means fixed. Increased use of conveyors, chutes, elevators, and other automatic equipment will decrease the need for employees to handle the material.

As shown, the prepared material on trays for drying and also in spreading the material on the blancher belt, it is necessary to spread it uniformly over the surface. This allows for proper air circulation and avoids large clumps which may not dry. In blanching, a uniform spread insured adequate penetration of heat to all pieces of the vegetable. An automatic device for doing this spreading will reduce the number of employees needed at these points.

The number of men that are employed on sorting and trimming belts will have a varied effect on the operation of the plant. In the number of men employed, more than will be spent on each potato or other vegetable, thus reducing waste and insuring a better dried product. Careful sorting and trimming will decrease the amount of dried material discarded in the final inspection and decrease the likelihood of product rejection. There will, however, be an optimum point for the most economical operation of the plant in obtaining an acceptable product.

The dry material cost and labor cost per pound of dry product are directly and heavily influenced by preparation losses. A saving of even 5% in preparation losses (e.g. a decrease from 25% to 20% preparation loss) may justify the expense for a number of additional men per shift on the sorting and trimming belt. Improvement in the quality of the final product due to additional care in preparation and decrease in waste disposal cost may also be weighing factors in determining whether an increase in the number of sorters and trimmers is warranted.

Since the number of final inspectors needed is small, the operations of the screening and final inspection have been combined. This avoids the necessity of providing a conveying belt or other means of passing the product before inspectors. The product can be inspected by the tray inspectors, either on the tray before screening or on a table top after screening, the latter being essential when wooden trays are used.

It is assumed that the extra men shown on the accompanying charts will assist in the actual processing of the material, in care and operation of the equipment, and in removal of wastes from the plant.

The tables and charts assume continuous operation of the plant in three shifts. Since actual working time in an 8-hour shift may be only 7 hours, the indicated hourly capacities are only an average of quantities handled during the entire 8 hours. Quantities handled in any one hour of actual operation will have to be slightly higher if the assumed production is to be maintained. The number of employees indicated should be sufficient to cover this difference.



# SUMMARY OF COSTS

Preparation, Final Inspection and Packaging Equipment,  
and Labor Requirements in  
Vegetable Dehydration at a Plant Capacity of 1,670 Pounds per Hour

## Unprepared Basis

Name of Vegetable	Shrinkage Ratio	Equipment Cost			Labor Cost	
		Total	Wet (Unpre- pared)	Dry	Wet (Unpre- pared)	Dry
		\$	\$	\$	\$	\$
Table Beets	13 to 1	7,350	368.	4,778.	1.17	15.3
Cabbage	19 to 1	5,925	296.	5,629	0.96	12.1
Carrots	10 to 1	7,165	358.	3,582.	1.12	11.2
Onions	14 to 1	4,765	238.	3,236	0.96	12.5
Potatoes	7 to 1	8,100	405.	2,835	1.56	10.9
Sweet Potatoes	4 1/2 to 1	9,335	467.	2,100.	1.23	5.6
Turnips	10 to 1	7,315	366.	3,658	1.16	11.6

1/ Equipment cost per ton handled per 24-hour day.

Capacities per Unit of Time  
In a Vegetable Dehydration Plant  
Capable of Handling 1,670 Pounds per Hour

(Unprepared Basis)

Form Prepared	Beets	Cabbage	Carrots	Onions	Potatoes	Sweet Potatoes (Yams)
	Slices	Shreds	Slices	Slices	Strips	Slices
<u>Unprepared basis:</u>						
Tons per 24-hour day	20	20	20	20	20	20
Pounds per 24-hour day	40,000	40,000	40,000	40,000	40,000	40,000
Pounds per hour	1,670	1,670	1,670	1,670	1,670	1,670
Pounds per minute	28	28	28	28	28	28
Number of women coring		3				
Pounds per woman per hour		555				
Pounds per woman per minute		9.3				
Number of retorts	1					
Blanching time in minutes	10					
Minutes per charge per retort - loading, blanching & unloading	20					
Charges per hour	3					
Pounds per charge	560					
Cars or crates per charge	1					
Pounds per car or crate	560					
Trays per car	5					
Pounds per tray	112					
<u>Prepared basis:</u>						
Assumed preparation loss	30%	25%	25%	15%	25%	
Tons per 24-hour day	14	15	15	17	15	
Pounds per 24-hour day	28,000	30,000	30,000	34,000	30,000	
Pounds per hour	1,170	1,250	1,250	1,420	1,250	
Pounds per minute	20	21	21	24	21	
Number of women sorting, tapping & trimming	10		10	8	20	
Pounds per woman per hour	115		125	180	65	
Pounds per woman per minute	2.0		2.1	3.0	1.0	
Assumed blancher loading - lbs. per square foot		1.5	2.0		2.0	
Assumed blanching time in minutes		3	4		4	
Pounds in blancher at any one time		63	83		83	
Square feet of blancher needed		42	42		42	
Assumed tray loading - lbs. per square foot	1.5	1.2	1.5	1.2	1.5	
Pounds per car	590	475	590	475	590	



Capacities per Unit of time  
In a Vegetable Dehydration Plant  
Capable of Handling 1,670 Pounds per Hour (cont'd)

(Unprepared Basis)

	Beets	Cabbage	Carrots	Onions	Potatoes	Sweet Potatoes (Yams)	Turnips
<u>Units Prepared</u>	Slices	Shreds	Slices	Slices	Strips	Slices	Slices
Cars per 24-hour day	47	63	51	72	51	51	54
Cars per hour	2.0	2.6	2.1	3.0	2.1	2.1	2.2
Minutes per car	30	23	29	20	29	29	27
Trays per car	22	22	22	22	22	22	22
Pounds per tray	27	21.6	27	21.6	27	27	27
Trays per 24-hour day	1,040	1,390	1,110	1,570	1,110	1,110	1,190
Trays per hour	43	58	46	65	46	46	50
Trays per minute	0.72	0.97	0.77	1.1	0.77	0.77	0.83
Seconds per tray	85	60	80	55	80	80	70
<u>Dried Basis</u>							
Assumed overall shrinkage ratio	13 to 1	19 to 1	10 to 1	14 to 1	7 to 1	12 to 1	10 to 1
Cars per 24-hour day	3,080	2,117	4,000	2,860	5,710	8,890	4,000
Pounds per hour	130	90	165	120	240	370	165
Pounds per minute	2.1	1.5	2.8	2.0	4.0	6.2	2.8
Pounds per 5-gallon can	10	5	14	9	10	13	6
Cans per 24-hour day	310	420	285	320	570	685	665
Cans per hour	13	18	12	13	24	29	28
Minutes per can	4.6	3.3	5.0	4.6	2.5	2.1	2.1

## TABLE BEETS

Preparation, Packing, Loading and Shipping

## Labor Requirements

In a Dehydration Plant Capable of Handling 1,670 Pounds per Hour

## Unprepared Basis

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
Feeding to Preparation Line			1 M
Washing	Rotary bar washer Drum size - 25" x 8 $\frac{1}{2}$ " With 1 $\frac{1}{2}$ h.p. motor	\$ 600.	
Blanching - 10 minutes at 5 pounds pressure in retorts	Horizontal retort - 2 car capacity Cylinder - 54" x 7 $\frac{1}{2}$ " 20 trays and 4 retort cars	1,050. 175.	2 M
Peeling	Continuous peeler With 3 h.p. motor	1,100.	
Cutting and Trimming	Belt conveying sorter Belt size - 30" x 15" With 1 h.p. motor	800.	10 F
Washing	Washer elevator with water boot Draper width - 18" With $\frac{1}{2}$ h.p. motor	400.	
Slicing	Slicer with $\frac{1}{2}$ h.p. motor	475.	
Rolling and Stacking	Rollers, scales and other loading equipment are small items. These are included in cost of accessory equipment. See below		2 F 2 M
Moving Cars and Drying			1 M
Scraping Trays	Table tops over bins	200.	4 M
Final Inspecting	Inspection done by employees scraping trays.		
Packaging and Preparing for Shipping	Scales, table and sealing equipment	100.	1 F 1 M

TABLE EFETS (continued)

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>
General - Foreman Helpers, cleanup, washing trays, and maintenance		
Sub-total		\$4,900.
Add 40% for installation and accessory equipment; 50% for same plus improvised items.	50%	2,450.
Total		\$7,350.
Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis)		\$ 368.
Labor Cost per Pound - (13 to 1 overall shrinkage ratio) (Based on the labor cost per hour)	13 Women 260¢ per hour \$ 7.80 14 Men 275¢ " " 10.50 1 Foreman 1.25 Labor cost per wet pound (1,670 lbs) Labor cost per dry pound (128 lbs)	\$ 14.55 1.17 15.3
Steam Generating - Approximate Boiler Horsepower Needed - (2½ b.h.p. per ton per day) For blanching only. Approximate Cost of Boiler if operated at Rated Capacity	50 b.h.p.	\$4,000.

### Unprepared Basis

### Description of Equipment

Cost

Labor

Equipment for feeding to the line will probably have to be improvised for this size plant \$1,000.

Table - 3' x 10'  
3 Improvised cabbage corers  
With  $\frac{1}{2}$  h.p. motor  
located over table

75.

35

Rotary bar washer  
Drum size - 25" x 8 $\frac{1}{2}$ "  
With 1 $\frac{1}{2}$  h.p. motor.

600.

Kraut cutter  
20" disc  
With 1 h.p. motor

325.

14

Blanching, 3 minutes - Loading on blancher belt,  $1\frac{1}{2}$  pounds per square foot.

Wire belt blancher  
Overall length - 25'  
Covered area - 30" x 17'  
With 1½ h.p. motor

1,500.

Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below

2

2

## Scraping Trays

## Table tops over bias

200. 21

Inspection done by employees  
scraping trays.

## Packaging and Preparing for Shipping

Scales, table, and sealing equipment

100.

129

4



- 11 -  
CABBAGE (continued)

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
General - Foreman			1 M
Helpers, cleanup, washing trays, and maintenance			3 M
Sub-total		\$3,950.	
Add 40% for installation and accessory equipment; 50% for same plus improvised items.	50%	1,975.	
Total		<u>\$5,925</u>	
Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis)		<u>\$ 296</u>	
Labor Cost per Pound -	7 Women @ 60¢ per hour \$ 4.20		
(19 to 1 overall shrinkage ratio)	14 Men @ 75¢ " " 10.50		
(Based on the labor cost per hour)	1 Foreman 1.25	<u>\$ 15.95</u>	
	Labor cost per wet pound (1,670 lbs)		0.96¢
	Labor cost per dry pound (88 lbs)		18.1 ¢
Steam Generating - Approximate Boiler Horsepower Needed (2 b.h.p. per ton per day) For blanching only.		40 b.h.p.	
Approximate Cost of Boiler if Operated at Rated Capacity		\$3,400.	

LA 373

Preparation, Final Inspection and Packaging Equipment, and  
Labor Requirements  
for a Preparation Plant Capable of Handling 1,000 Pounds per Hour

Unprepared Basis

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
Feeding to Preparation Line			1 M
Washing	Rotary bar washer Drum size - 25" x 8½" With 1½ h.p. motor	\$ 600.	
	Continuous peeler With 3 h.p. motor	1,000.	
Peeling and Trimming	Belt conveying sorter Belt size - 30" x 15" With 1 h.p. motor	800.	10 F
Slicing	Slicer With ½ h.p. motor	475.	
Spreading on Blancher Belt			1 F
Washing	Sprays on front end of blancher. Included in blancher cost.		
Blanching, 4 Minutes - Loading on blancher belt, two pounds per square foot.	Wire belt blancher Overall length - 25' Covered area - 30" x 17' With 1½ h.p. motor	1,500.	
Tray Loading and Stacking	Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below.		2 F 2 M
Moving Cars and Drying			1 M
Scraping Trays	Table tops over bins	200.	4 M
Final Inspecting	Inspection done by employees scraping trays.		
Packaging and Preparing for shipping	Scales, table, and sealing equipment	100.	1 F 1 M

# CANADA (continued)

Operation	Equipment Description of Equipment	cost	Labor
General - Foreman Helpers, cleanup, tray washing, and maintenance.			
Sub-total		\$4,715.	
Add 40% for installation and accessory equipment; 50% for same plus improvised items.	50%	\$2,357.50	
Total		\$7,072.50	
Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis)		\$1.12	
Labor Cost per Pound - (10 to 1 overall shrinkage ratio) (Based on the labor cost per hour)	14 Women @ 60¢ per hour \$8.40 12 Men @ 75¢ " " 9.00 1 Foreman 1.25 Labor cost per wet pound (1,670 lbs) 1.12 Labor cost per dry pound (167 lbs) 1.12	\$13.65	
Steam Generating - Approximate Boiler Horsepower Needed - (2 b.h.p. per ton per day) For blanching only.	40 b.h.p.		
Approximate Cost of Boiler if Operated at Rated Capacity			

UNIONS

Preparation, Final Inspection and Packaging Equipment, and  
Labor Requirements  
In a Dehydration Plant Capable of Handling 1,670 Pounds per Hour

Unprepared Basis

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
Feeding to Preparation Line			1 M
Peeling	Continuous peeler With 3 h.p. motor	\$1,100.	
Sorting and Trimming	Belt conveying sorter Belt size - 30" x 12" With 1 h.p. motor	700.	8 F
Washing	Rotary bar washer Drum size - 25" x 8½" With 1½ h.p. motor	600.	
Slicing	Slicer With ½ h.p. motor	475.	
Tray Loading and Stacking	Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below		2 F 2 M
Moving Cars and Drying			1 M
Scraping Trays	Table tops over bins	200.	4 M
Visual Inspecting	Inspection done by employees scraping trays.		
Packaging and Preparing for Shipping	Scales, table, and sealing equipment	100.	1 F 1 M
General - Foremen			1 M
Helpers, cleanup, washing trays, and maintenance.			2 M
Sub-total		\$3,175	
Add 40% for installation and accessory equipment; 50% for same plus improvised items.	50%	1,590.	
Total		<u>\$4,765.</u>	



ONIONS (continued)

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
Equipment Cost per Ton Handled per 24-Hour Day (Unprepared Basis)		\$ 238.	
	11 Women @ 60¢ per hour	\$ 6.60	
Labor Cost per Pound -	11 Men @ 75¢ " "	8.25	
(14 to 1 overall shrinkage)	1 Foreman	1.25	\$ 16.10
(Based on the labor cost per hour)	Labor cost per wet pound (1,670 lbs)		0.96
	Labor cost per dry pound (119 lbs)		13.5

# POTATOES

Preparation, Final Inspection and Packaging Equipment, and  
Labor Requirements  
in a Dehydration Plant Capable of Handling 1,670 Pounds per Hour

Unprepared Basis

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
Feeding to Preparation Line			1 M
Washing	Rotary bar washer Drum size - 25" x 8½" With 1½ h.p. motor	\$ 600.	
Sizing	Improvised wood-slat sizer	50.	1 M
Peeling	Continuous peeler With 3 h.p. motor	1,100.	
Sorting and Trimming	Belt conveying sorter Belt size - 30" x 30" With 2 h.p. motor	1,150.	
	Strip cutter and slicer With 2 h.p. motor	700.	
Spreading on Blancher Belt			1 F
Washing	Sprays on front end of blancher - Included in blancher cost.		
Blanching, 4 Minutes - Loading on blancher belt, two pounds per square foot.	Wire belt blancher Overall length - 25' Covered area - 30" x 17" With 1½ h.p. motor	1,500.	
Tray Loading and Stacking	Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below.		2 F 2 M
Moving Cars and Drying			1 M
Scraping Trays	Table tops over bins	200.	
Final Inspecting	Inspection done by employees scraping trays.		

# POTATOES (continued)

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Labor</u> <u>Cost</u>
Packaging and Preparing for Shipping	Scales, table, and sealing equipment	1 \$ 100. 2
General - Foreman Helpers, cleanup, washing trays, and maintenance		
Sub-total		\$5,400.
Add 40% for installation and accessory equipment; 50% for same plus improvised items	50%	2,700.
Total		
Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis)		
Labor Cost per Pound - (7 to 1 overall shrinkage ratio) (Based on the labor cost per hour)	24 Women @ 60¢ per hour \$14.40 14 Men @ 75¢ " " 10.50 1 Foreman 1.25 Labor cost per wet pound (1,670 lbs) Labor cost per dry pound (240 lbs)	1.06 10.8
Steam Generating - Approximate Boiler Horsepower Needed - (2 b.h.p. per ton per day) For blanching only. Approximate Cost of Boiler if Operated at Rated Capacity	40 b.h.p.	

SWEET POTATOES

Preparation, Final Inspection and Packaging Equipment, and  
Labor Requirements  
In a Dehydration Plant Capable of Handling 1,670 Pounds per Hour

Unprepared Basis

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
Feeding to Preparation Line			1 M
Washing	Rotary bar washer Drum size - 25" x 8½" With 1½ h.p. motor	\$ 600.	
Soaking, 10 Minutes in Boiling Water	Continuous hot water scalding Tank - 24" x 10" With 1½ h.p. motor	1,100.	
Peeling	Continuous peeler With 3 h.p. motor	1,100.	
Cutting and Trimming	Belt conveying sorter Belt size - 30" x 18" With 1 h.p. motor	850.	12 F
Slicing	Slicer With ½ h.p. motor	475.	
Spreading on Blancher Belt			1 F
Flushing	Sprays on front end of blancher - Included in blancher cost.		
Blanching, 6 Minutes - Loading on blancher belt, two pounds per square foot.	Wire belt blancher Overall length - 34' Covered area - 30" x 25' With 1½ h.p. motor	1,800.	
Conveying, Loading and Stacking	Rollers, scales, and other loading equipment are small items, being included as accessory equipment.		2 F 2 M
Loading Cars and Drying			1 M
Wrapping Trays	Table tops over bins	200.	4 M
Final Inspecting	Inspection done by employees scraping trays.		



# SWEET POTATONS (continued)

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>1</u>
Packaging and Preparing for	Scales, table, and sealing equipment	\$ 100.	
General - Foreman			1
Helpers, cleanup, washing trays, and maintenance			3
Sub-total		86,225.	
Add 40% for installation and accessory equipment; 50% for same plus improvised items.	50%	3,110.	
Total		89,335.	
Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis)		\$ 467	
Labor Cost per Pound - (4½ to 1 overall shrinkage ratio) (Based on the labor cost per hour)	16 Women 360¢ per hour \$ 9.60 13 Men 375¢ " " 9.75 1 Foreman 1.2 Labor cost per wet pound (1,670 lbs) Labor cost per dry pound (370 lbs)		1 5
Steam Generating - Approximate Boiler Horsepower Needed - (3 b.h.p. per ton per day) For blanching and scalding only	60 b.h.p.		
Approximate Cost of Boiler if Operated at Rated Capacity		\$4,400.	

# TURNIPS

Preparation, Final Inspection and Packaging Equipment, and  
Labor Requirements  
In a Dehydration Plant Capable of Handling 1,670 Pounds per Hour

Unprepared Basis

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Notes</u>
Feeding to Preparation Line			1 F
	Rotary bar washer Drum size - 25" x 8½" With 1½ h.p. motor	\$ 600.	
	Continuous peeler With 3 h.p. motor	1,000.	
	Belt conveying sorter Belt size - 30" x 15" With 1 h.p. motor	800.	
Slicing	Slicer With ½ h.p. motor	475.	
Spreading on Blancher Belt			1 F
Washing	Sprays on front end of blancher - Included in blancher cost.		
Blanching, 4 Minutes -- Loading on blancher belt, two pounds per square foot.	Wire belt blancher Overall length - 26' Covered area - 30" x 18" With 1½ h.p. motor	1,600.	
Tray Loading and Stacking	Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below.		2 F 2 F
Moving Cars and Drying			1 F
Scrapping Trays	Table tops over bins	200.	1 F
Final Inspecting	Inspection done by employees scrapping trays.		

## TURNIPS (continued)

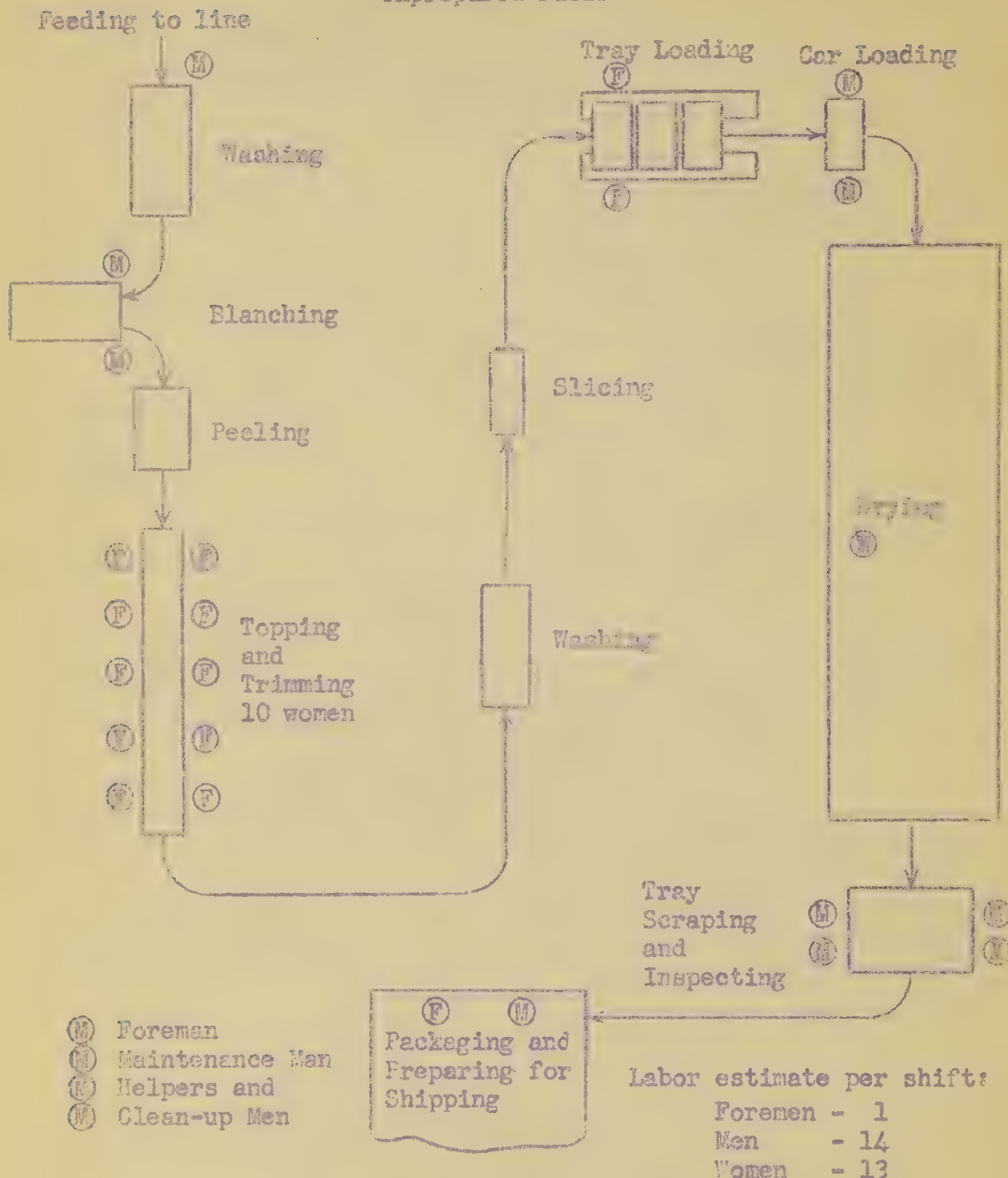
<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
Packaging and Preparing for Shipping	Scales, table, and sealing equipment	100.	1 F 2 M
General - Foreman			1 M
Helpers, cleanup, washing trays, and maintenance			3 M
Sub-total		\$4,875.	
Add 40% for installation and accessory equipment; 50% for same plus improvised items.	50%	2,440.	
Total		<u>\$7,315.</u>	
Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis)		<u>\$ 366.</u>	
Labor Cost per Pound -	14 Women @ 60¢ per hour \$8.40		
(Based on 1 overall shrinkage ratio)	13 Men @ 75¢ " " 9.75		
(Based on the labor cost per hour)	1 Foreman 1.25	<u>\$ 19.40</u>	
	Labor cost per wet pound (1,670 lbs)		1.16¢
	Labor cost per dry pound (167 lbs)		11.6 ¢
Steam Generating - Approximate Boiler Horsepower needed - (2 b.h.p. per ton per day) For blanching only.	40 b.h.p.		
Approximate Cost of Boiler if Operated at Rated Capacity		\$3,400.	

# BEETS

## DEHYDRATION FLOW SHEET

1670 Pounds per Hour

Unprepared Basis

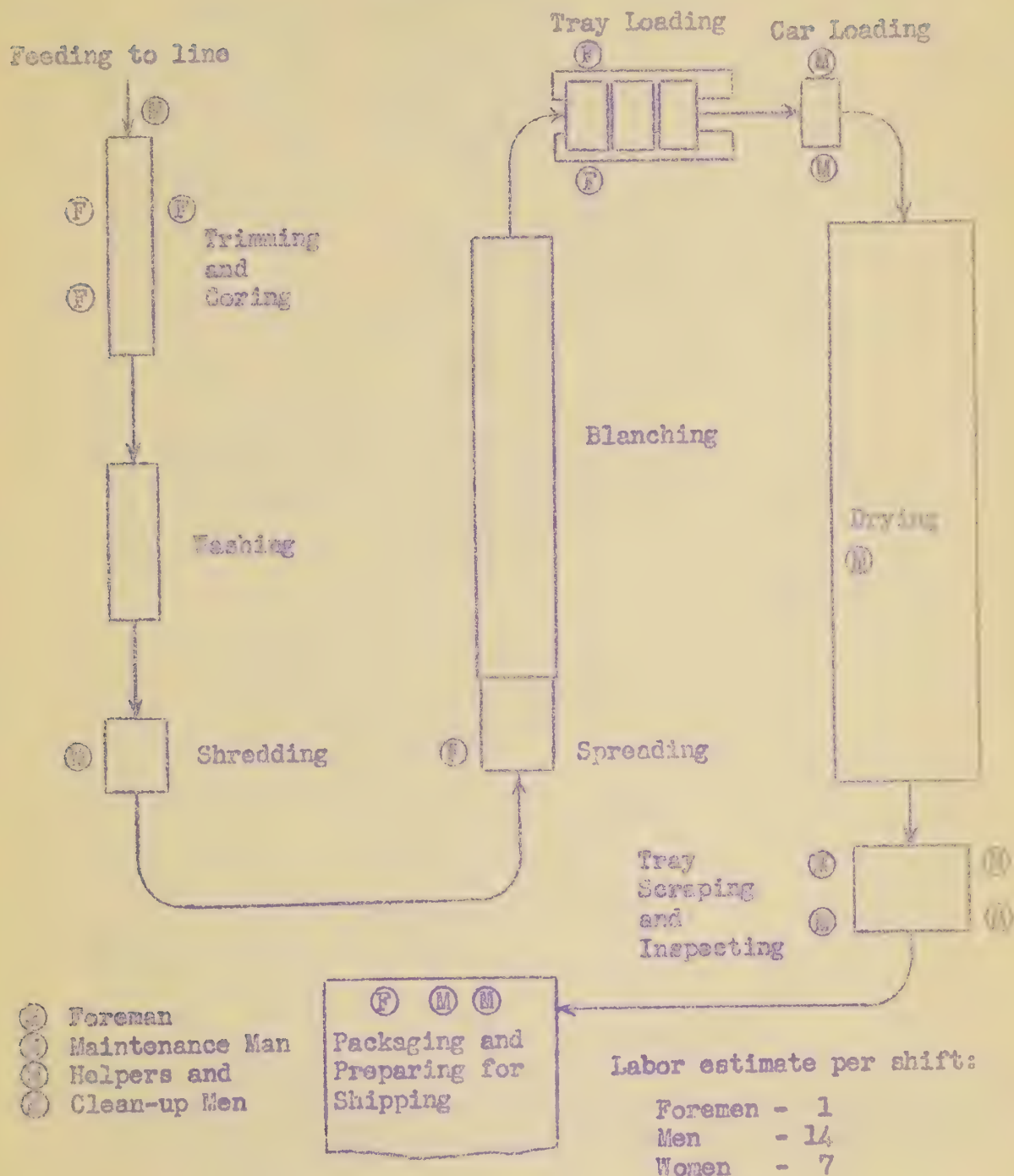




# DEHYDRATION FLOW SHEET

1670 Pounds per Hour

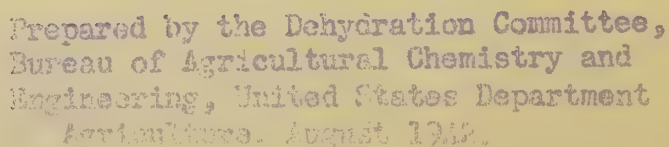
Unprepared Basis



Prepared by the Dehydration Committee,  
Bureau of Agricultural Chemistry and  
Engineering, United States Department  
of Agriculture, August 1942.

1670 Pounds per Hour

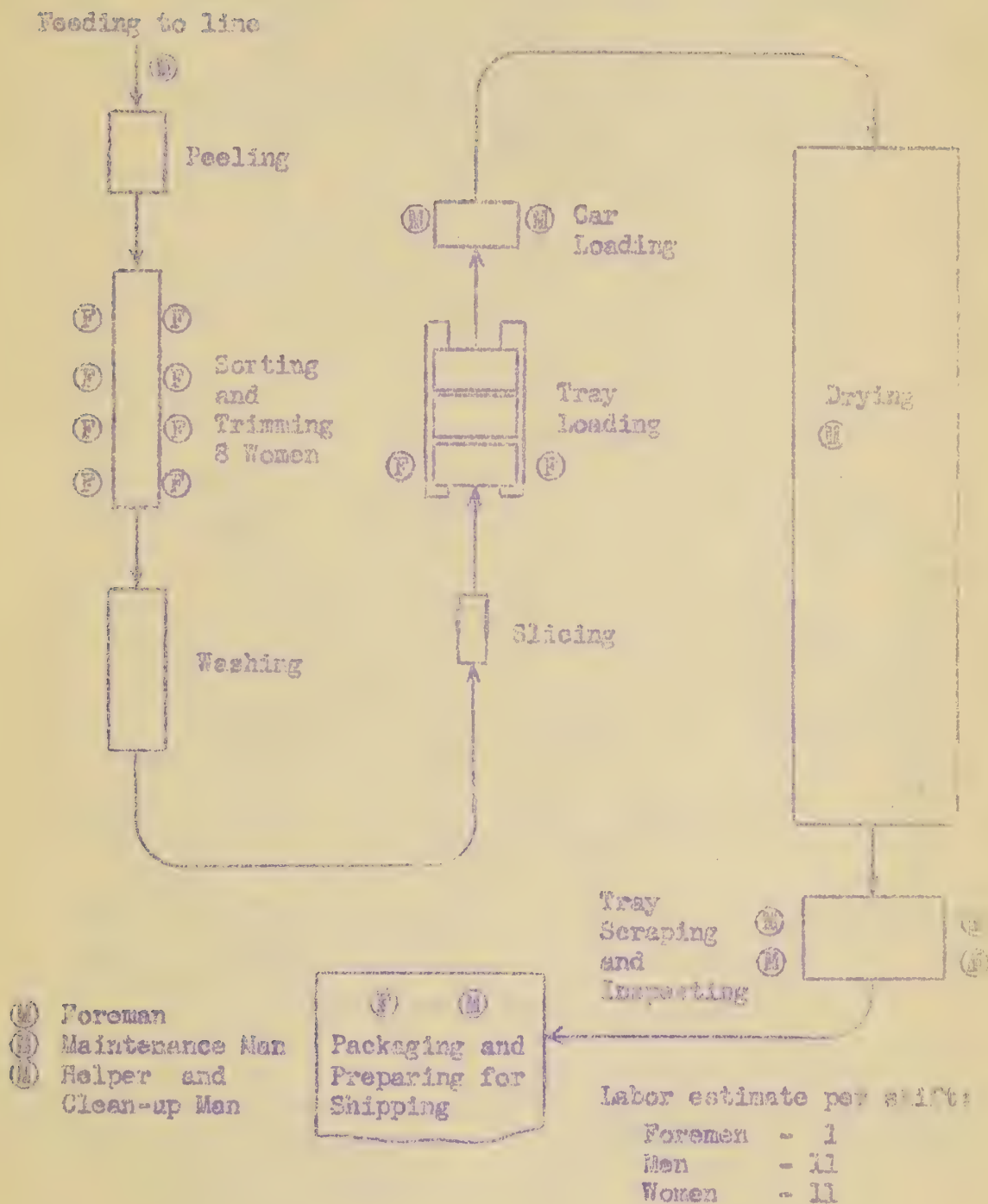
## Unprepared Basis



# DEHYDRATION FLOW SHEET

1670 Pounds per Hour

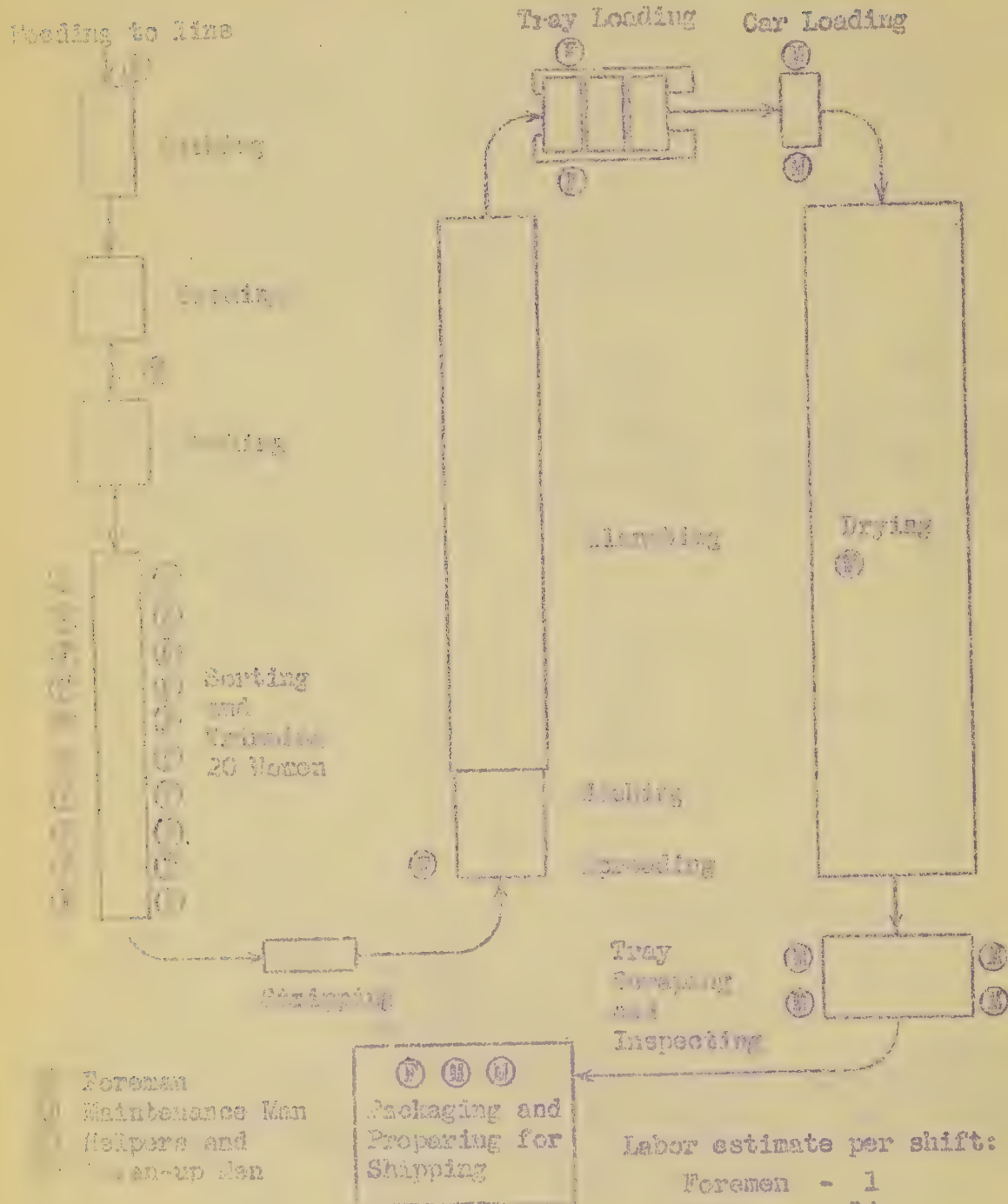
Unprepared Basis



# POTATOES DEHYDRATION FLOW SHEET

2670 Pounds per Hour

Unprepared Basis

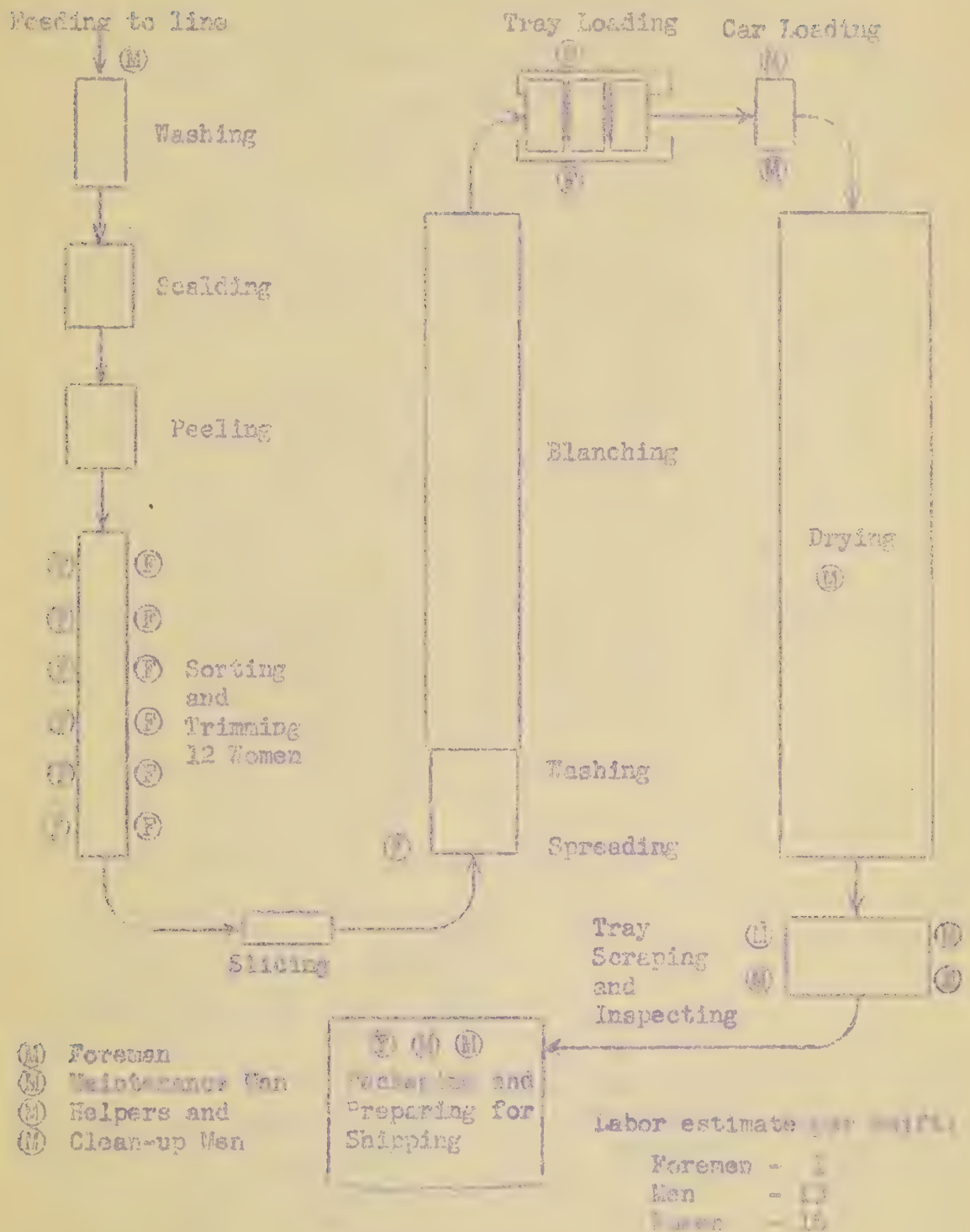




DEHYDRATION FLOW SHEET

1670 Pounds per Hour

Unprepared Basis

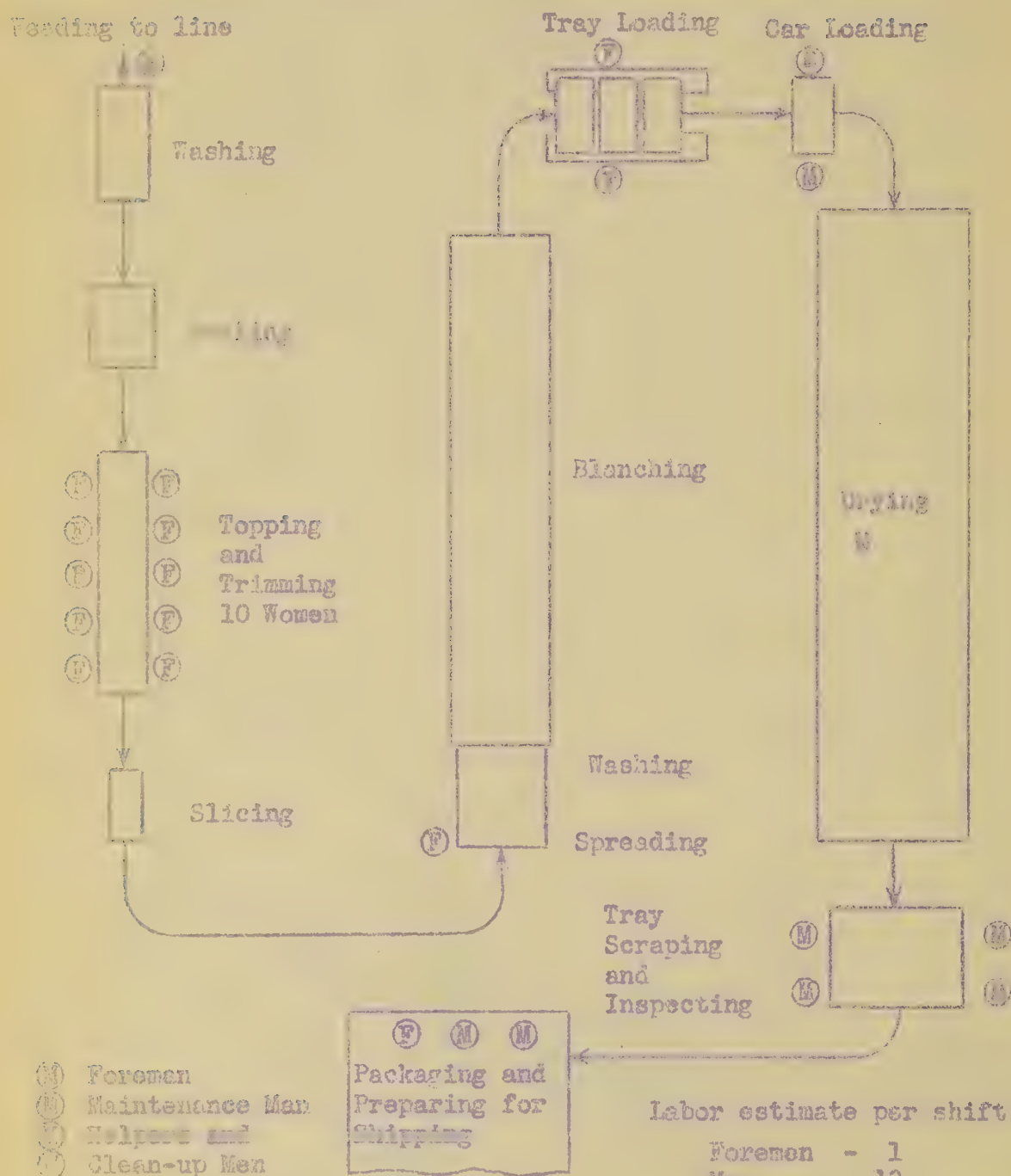


Prepared by the Dehydration Committee  
Bureau of Agricultural Chemistry and  
Engineering, United States Department  
of Agriculture, August 1942.

TURNIPS  
DEHYDRATION FLOW SHEET

1670 Pounds per Hour

Unprepared Basis



Prepared by the Dehydration Committee,  
Bureau of Agricultural Chemistry and  
Engineering, United States Department  
of Agriculture

If further detailed information is  
desired, inquiries should be addressed  
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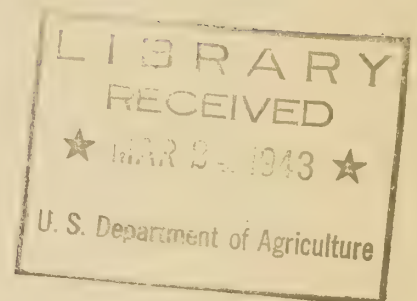




Dehydration Committee  
Bureau of Agricultural Chemistry and Engineering  
U. S. Department of Agriculture

ESTIMATES OF EQUIPMENT COSTS AND LABOR REQUIREMENTS  
IN  
VEGETABLE DEHYDRATION

Plant Capacity---3,330 Pounds Per Hour  
(Unprepared Basis)



Note:

Preparation, final inspection and packaging equipment are the only types of equipment considered in this report. All labor requirements except clerical and shipping are included.

August 1942



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Preparation, Final Inspection, and Packaging Equipment,  
and Labor Requirements in  
Vegetable Dehydration at a Plant Capacity of 3,300 Pounds per Hour,  
Unprepared Basis

This discussion deals with the labor requirements and cost of preparation and packaging equipment in dehydration plants capable of handling 3,300 pounds per hour, unprepared basis, or 40 tons per 24-hour day. The vegetables considered are:

Table Beets	Onions	Sweet Potatoes (Yams)
Cabbage	Potatoes	Turnips (Rutabagas)
Carrots		

Costs of equipment and labor for vegetable drying are subject to wide variation. The ability to improvise certain items may permit substantial savings in plant investment as compared to a plant using standard cannery equipment. Proper plant layout may even eliminate some items. The balance between labor and machinery is a very important factor. The initial cost of a labor-saving machine may be large, but the labor cost saved may be much larger than capital and operating charges on the machine. Relative availability of labor and machinery may determine the proportion of labor and machine operation in a plant.

Equipment listed herein and indicated methods of operation are intended to be merely suggestive. Other items of equipment as well as other operating procedures may be equally satisfactory or even better. For instance, mechanical abrasive peelers have been assumed. Live peeling, if permitted by purchase specifications, may be preferable on carrots, potatoes, and other hard root vegetables. Other peeling methods, for example, carbonization by flame or radiant heat, followed by vigorous scrubbing, have also shown promise on an experimental basis. Carrots, turnips, and beets are shown as being peeled before topping. Under certain conditions it may be advisable to do the topping before peeling and the trimming after peeling. Standard abrasive peelers have not proven entirely satisfactory on onions. Operators have adopted various expedients to overcome this difficulty.

Costs and descriptions of equipment are based upon prices and information from established manufacturers in this field. The labor set-ups shown are based upon cannery operations and the operations of present commercial dehydrators. They will vary appreciably from plant to plant. If the items of equipment or sequence and methods of operations are different from those given here, the labor set-up must be modified accordingly.

The accompanying tables show only major items of equipment needed in the

preparation of vegetables for drying and in the final inspection and packaging of the dry product. It is recognized that elevators and conveyors may be major items of cost. They have not been specifically included, except in two special instances, because considerable provisioning will usually be done by the plant operator in the installation of these items of equipment or in the arrangement of other equipment so as to eliminate the necessity for their use. A part of the allowance for installation and accessory equipment is intended for this purpose.

Some peeling plants have the tendency to over-peel smaller size vegetables and incompletely peel larger ones. Hence it is preferable to put only one size through the peeler at a time. This involves the use of a grader or sizer or the purchase of pre-graded vegetables. A rubber-spool grader may cost from \$200 to \$700, whereas a simple slat grader that might be satisfactory may be built at the plant at a cost which is only a fraction of the cost of a commercial grader.

A water spray at the beginning of the blancher belt is quite satisfactory in washing the sliced, sliced, or striped vegetables. A separate washer to do the same work may cost several hundred dollars. Such a water spray at the front end of the blancher belt tends to prevent steam leakage in the preparation room by condensing steam escaping from this end of the blancher.

The amount of steam necessary for blanching will vary from plant to plant depending upon losses from the blancher and care in the avoidance of steam leakage. The range may be from 1 to 3 boiler horsepower for each ton of unprepared vegetables handled per 24-hour period. Except for sweet and new potatoes, a requirement of 2-boiler horsepower per ton per day has been assumed. Due to retort blanching used for beets, a slightly larger amount is considered necessary. Sweet potatoes are peeled as well as blanched. Due to this double heating, they require somewhat more steam capacity. The plant operator can lessen the investment in steam boilers by insuring proper plant operation to minimize the steam losses and by operating the steam boiler above its rated capacity.

Since the continuous peeler will need periodic cleaning, provision has been made for a batch peeler to carry the load while the other peeler is out of action and to handle odd sizes during normal operation. Smaller than this peeler, the line-up provides for little or no stand-by equipment. Where there is a possibility that the stopping of any machine will interrupt the continuous flow of the product through the plant, some means of substitute operation should be available or there should be storage facilities for the product so that it will not deteriorate while standing.



No provision for waste disposal equipment has been made in these estimated costs. Since disposal of waste is a very important and sometimes costly factor, it cannot be overlooked in setting up a plant. Each plant may have its own method of waste disposal, but it is probable that in the case of potatoes and sweet potatoes, the most common method will involve carrying of wastes from the plant by water. This will necessitate a method of separating suspended solids from the water by screening, settling, or otherwise. These solids may be hauled away, incinerated, or processed for byproduct values. The liquid effluent may be run into a sewer, a running stream, or to other places of disposal. Other vegetable wastes may be hauled away, burned, or treated for byproduct recovery, but will usually involve a less serious sewage problem. Each of these methods will be subject to sanitary regulation. Due to the many factors involved, no attempt is being made at this time to show the cost of such equipment. Economical disposal of preparation wastes will usually require some ingenuity on the part of plant operators.

Only one form of prepared vegetable has been considered. Preparation of vegetables in other forms will necessitate the installation of other types of cutters and will usually entail an increase in cost. The labor set-up may also be affected to some extent by resulting differences in blancher loading, tray loading, and drying time.

In the case of onions, at least a portion of the product will usually be converted to a powder form. It is necessary to conduct this operation in a dry atmosphere and special equipment will have to be installed for this purpose. It is advantageous to conduct all color packing operations in an air-conditioned room at low humidity.

The cost of packaging equipment is based on the assumed use of 1-gallon cans. Recent practice has been to solder the top after filling the can with inert gas. A regulator valve for the gas, relatively inexpensive soldering equipment, and seals are the main items needed for this type of packaging. Other types of packaging might involve a larger capital investment. Automatic can sealers have been recently introduced. These use a plastic sealing material under the edge of the lid which eliminates the necessity for soldering. No increased capital investment is ordinarily involved in the use of the automatic can sealer since the machines are leased to the user. Equipment operating costs will be higher, due to the rental paid, but these will be more than offset by lower labor costs.

Inspection belts included are straight single-unit belts. Single-unit or some divided belts will involve higher equipment costs on the packing and weighing line. Their use may, however, result in reduced labor costs.

It is estimated that installation costs will amount to from 10 to 20% of the purchase price of the machinery. Valves, piping, wiring, trucks, hoists, scales, tools and other auxiliary equipment plus some allowance for improvised items may amount to an additional 30 to 40%. Together these will make a total of about 50% to be added to the purchase price to cover costs of installation and accessory items.

The number of employees needed to operate a plant is by no means fixed. Increased use of conveyors, chutes, elevators, and other automatic equipment will decrease the need for employees to handle the material.

In placing the prepared material on the trays for drying, it is necessary to spread it uniformly over the surface of the trays. This allows for proper circulation of the air to all of the material and avoids lumps which may not dry. An automatic device for spreading material on the trays and proper use of tray conveyors will reduce the number of people needed at this point. Automatic spreading on blancher belts will accomplish the same result.

The number of women that are employed on sorting and trimming belts will have a marked effect on the operation of the plant. As the number of women increases, more time will be spent on each potato or other vegetable, thus reducing waste and insuring a better dried product. Careful sorting and trimming will decrease the amount of dried material discarded in the final inspection, decrease the likelihood of product rejection, and probably decrease the number of women needed for the final inspection. There will, however, be an optimum point for the most economical operation of the plant in obtaining an acceptable product.

The raw material cost and labor cost per pound of dry product are directly and heavily influenced by preparation losses. A saving of even 5% in preparation losses (e.g., a decrease from 25% to 20% preparation loss) may justify the wages for a number of additional women per shift on the sorting and trimming belt. Improvement in the quality of the final product due to additional care in preparation and decrease in waste disposal cost may also be the deciding factors in determining whether an increase in the number of sorters and trimmers is warranted.

It is assumed that the extra men shown on the accompanying charts will assist in actual processing of the material, in care and operation of the equipment, and in removal of wastes from the plant.

The tables and charts assume continuous operation of the plant in three eight-hour shifts. Since actual working time in an 8-hour shift may be only 7 hours, the indicated hourly capacities are only an average of the quantities handled during the entire 8 hours. Quantities handled in any one hour of actual operation will have to be slightly higher if the assumed rate of production is to be maintained. The number of employees indicated should as a rule be sufficient to cover this difference.



# SUMMARY OF COSTS

Preparation, Final Inspection, and Packaging Equipment,  
and Labor Requirements in  
Vegetable Dehydration at a Plant Capacity of 3,330 Pounds per Hour

Unprepared Basis

Name of Vegetable	Shrinkage Ratio	Equipment Cost			Labor Cost	
		Total	Wet (Unpre- pared)	Dry	Wet (Unpre- pared)	Dry
		\$	\$	\$	\$	\$
Table Beets	13 to 1	11,250.	281.	3,556.	0.97	12.6
Cabbage	19 to 1	10,800.	270.	5,130.	0.78	14.9
Carrots	10 to 1	11,700.	293.	2,925.	0.97	9.7
Celery	14 to 1	8,475.	212.	2,966.	0.84	11.8
Chickpeas	7 to 1	13,830.	345.	2,415.	1.43	5.8
Small Potatoes	4½ to 1	14,310.	371.	1,671.	1.11	5.8
Pumpkins	10 to 1	11,700.	293.	2,925.	0.98	9.8

1/ Equipment cost per ton handled per 24-hour day.

Unprepared per Unit of Size  
In a Vegetable Dehydration Plant  
Capable of Handling 3,330 Pounds per Hour

(Unprepared Basis)

	Beets	Cabbage	Carrots	Onions	Potatoes	Potatoes (Yams)
<u>Form Prepared</u>	Slices	Shreds	Slices	Slices	Strips	Slices
<u>Unprepared basis:</u>						
Pounds per 24-hour day	40	40	40	40	40	40
Pounds per 24-hour day	80,000	80,000	80,000	80,000	80,000	80,000
Pounds per hour	3,330	3,330	3,330	3,330	3,330	3,330
Pounds per minute	56	56	56	56	56	56
Number of women coring		6				
Pounds per woman per hour		555				
Pounds per woman per minute		9.3				
Number of retorts	1					
Blanching time in minutes	10					
Minutes per charge per retort -						
Loading, blanching & unloading	20					
Charges per hour	3					
Pounds per charge	1,110					
Cars or crates per charge	2					
Pounds per car or crate	560					
Trays per car	5					
Pounds per tray	112					
<u>Prepared basis:</u>						
Assumed preparation loss	30%	25%	25%	15%	25%	25%
Pounds per 24-hour day	28	30	30	34	30	30
Pounds per 24-hour day	56,000	60,000	60,000	68,000	60,000	60,000
Pounds per hour	2,330	2,500	2,500	2,830	2,500	2,500
Pounds per minute	39	42	42	47	42	42
Number of women sorting,						
tipping & trimming	18		20	16	40	
Pounds per woman per hour	130		125	175	65	
Pounds per woman per minute	2.2		2.1	3.0	1.0	
Assumed blancher loading -						
lbs. per square foot		1.5	2.0		2.0	
Assumed blanching time in minutes		3	4		4	
Pounds in blancher at any one						
time		125	165		165	
Square feet of blancher needed		85	85		85	
Assumed tray loading -						
lbs. per square foot	1.5	1.2	1.5	1.2	1.5	
Pounds per car	590	475	590	475	590	

Capacities per Unit of Time  
In a Vegetable Dehydration Plant  
Capable of Handling 3,330 Pounds per Hour (cont'd)

(Unprepared Basis)

Form Prepared	Beets Cabbage		Carrots	Onions	Potatoes	Sweet Potatoes (Yams)	Turnips
	Slices	Shreds	Slices	Slices	Strips	Slices	Slices
Cars per 24-hour day	95	125	100	145	100	100	110
Cars per hour	3.9	5.3	4.2	6.0	4.2	4.2	4.5
Minutes per car	15	11	14	10	14	14	13
Trays per car	22	22	22	22	22	22	22
Pounds per tray	27	21.6	27	21.6	27	27	27
Trays per 24-hour day	2,070	2,780	2,220	3,150	2,220	2,220	2,370
Trays per hour	86	120	93	130	93	93	99
Trays per minute	1.4	1.9	1.6	2.2	1.6	1.6	1.7
Seconds per tray	43	32	38	27	38	38	35
Assumed overall shrinkage ratio	13 to 1	19 to 1	10 to 1	14 to 1	7 to 1	4 $\frac{1}{2}$ to 1	10 to 1
Pounds per 24-hour day	6,150	4,210	8,000	5,710	11,430	17,780	8,000
Pounds per hour	260	175	330	240	480	740	330
Pounds per minute	4.3	2.9	5.6	4.0	7.9	12.0	5.6
Pounds per 5-gallon can	10	5	14	9	10	13	6
Cans per 24-hour day	620	340	570	630	1,140	1,370	1,330
Cans per hour	26	35	24	26	48	57	55
Minutes per can	2.3	1.7	2.5	2.3	1.3	1.1	1.1

TABLE THREE  
Preparation, Final Inspection and Packaging Equipment, and  
Labor Requirements  
In a Dehydration Plant Capable of Handling 3,330 Pounds per Hour

Unprepared Basis

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
Feeding to Preparation Line			2 M
Washing	Corrugated drum washer Drum size - 24" x 12" With 1½ h.p. motor	\$1,200.	
Blanching - 10 minutes at 5 pounds pressure in retorts.	Horizontal retort - 2 car capacity Cylinder - 54" x 7½' 30 trays and 6 retort cars	1,050. 250.	3 M
Peeling	Continuous peeler With 3 h.p. motor Stand-by batch peeler With 1½ h.p. motor	1,100. 600.	
Topping and Trimming	Belt conveying sorter Belt size - 30" x 27" With 1½ h.p. motor	1,050.	12 M
Washing	Washer elevator with water boot Draper width - 24" With 1 h.p. motor	500.	
Slicing	Cutter and slicer With 2 h.p. motor	700.	
Tray loading and Stacking	Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below.		2 M 3 M
Moving Cars and Drying			2 M
Scraping Trays	Scraping done over end of conveyor		4 M
Final Inspecting	Belt conveying sorter Belt size - 30" x 20" With 1½ h.p. motor		4 M
Packaging and Preparing for Shipping	Scales, table and sealing equipment	150.	2 M



TABLE THREE (continued)

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>
General - Foreman Helpers, cleanup, washing trays, and maintenance	
Sub-total	
Add 40% for installation and accessory equipment; 50% for same plus improvised items.	50%
Total	
Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis)	
Labor Cost per Pound - (13 to 1 overall shrinkage ratio) (Based on the labor cost per hour)	25 Women @ 60¢ per hour \$15.00 21 Men @ 75¢ " " 15. 1 Foreman  Labor cost per wet pound (3,330 lbs) Labor cost per dry pound (256 lbs)
Steam Generating - Approximate Boiler Horsepower Needed - (2½ b.h.p. per ton per day) For blancher only. Approximate Cost of Boiler if Operated at Rated Capacity	100 b.h.p.  \$6,000.

# CABBAGE

Preparation, Final Inspection and Packaging Equipment, and  
Labor Requirements  
In a Dehydration Plant Capable of Handling 5,330 Pounds per Hour

## Unprepared Basis

	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>
Feeding to Preparation Line	Belt conveyor Belt size - 18" x 60' With 3 h.p. motor	400.
Trimming and Coring	Belt conveying sorter Belt size - 30" x 12' With 1 h.p. motor 6 Improved cabbage corers With 1 h.p. motor Located over belt	750.
Washing	Corrugated drum washer Drum size - 24" x 12' With 1½ h.p. motor	600.
Shredding	Front cutter 32½" disc With 2 h.p. motor	2 1/2 600.
Spreading on Blancher Belt		
Blanching, 3 Minutes - Loading on blancher belt, 1½ pounds per square foot.	Wire belt blancher Overall length - 34' Covered area - 42" x 25' With 2 h.p. motor	2,000.
Tray Loading and Stacking	Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below.	2 3
Moving Cans and Drying		
Scraping Trays	Scraping cone over end of conveyor.	
Final Conveying	Belt conveying sorter Belt size - 30" x 20' With 1½ h.p. motor	400.

3x30x02 (continued)

<u>Operation</u>	<u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
Packaging and Preparing for shipping	Scales, table, and sealing equipment	\$ 150.	2 2
General - Foreman			1 M
Helpers, cleanup, washing trays, and maintenance			5 M
Sub-total		\$7,200	
Add 40% for installation and accessory equipment; 50% for same plus improvised items.		50% 3,600	
Total		<u>10,800</u>	
Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis)		<u>\$ 270</u>	
Labor Cost per Pound -	16 Women @ 60¢ per hour \$9.60		
[19 to 1 overall shrinkage ratio)	20 Men @ 75¢ " " 15.00		
Based on the labor cost per hour)	1 Foreman 1.50	\$ 26.10	
	Labor cost per wet pound (3,330 lbs)		
	Labor cost per dry pound (175 lbs)		
Steam Generating - Approximate Boiler Horsepower Needed (2 b.h.p. per ton per day) For blanching only.		80 b.h.p.	
Approximate Cost of Boiler if Operated at Rated Capacity		15,100	

# CARROTS

Operation, Final Inspection and Packaging Equipment, and  
Labor Requirements  
In a Dehydration Plant Capable of Handling 3,330 Pounds per Hour

## Unprepared Basis

	Description of Equipment	Cost	
Feeding to Preparation Line			
Washing	Corrugated drum washer Drum size - 24" x 12" With 1½ h.p. motor	\$1,200	
Peeling	Continuous peeler With 3 h.p. motor Stand-by batch peeler With 1½ h.p. motor	1,100 400	
Topping and Trimming	Belt conveying sorter Belt size - 30" x 30" With 2 h.p. motor  Cutter and slicer With 2 h.p. motor	1,100 400	
Spreading on Blancher Belt			
Washing	Sprays on front end of blancher Included in blancher cost.		
Blanching, ¼ Minutes - Loading on blancher belt, two pounds per square foot.	Wire belt blancher Overall length - 34' Covered area - 42" x 25" With 2 h.p. motor	2,000	
Tray loading and Stacking	Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below		
Moving Cars and Drying			
Scraping Trays	Scraping done over end of conveyor.		
Final Inspecting	Belt conveying sorter Belt size - 30" x 20" With 1½ h.p. motor	900	



<u>Operation</u>	<u>Description of Equipment</u>	<u>Cost</u>	<u>Labo</u>
Packaging and Preparing for Shipping	Scales, table, and sealing equipment	\$ 150.	1 M 2
General - Foreman			1 M
Helpers, cleanup try washing and maintenance.			5 M
Sub-total		\$7,800.	
Add 40% for installation and accessory equipment; 50% for same plus improvised items.		50% 3,900.	
Total		\$11,700	
Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis)		\$ 293.	
Labor Cost per Pound -	29 Women @ 60¢ per hour	\$17.40	
(10 to 1 overall shrinkage ratio)	18 Men @ 75¢ " "	13.50	
(Based on the labor cost per hour)	1 Foreman	1.50	\$ 32.40
	Labor cost per wet pound (3,330 lbs)		0.97¢
	Labor cost per dry pound (333 lbs)		9.7
Steam Generating - Approximate Boiler Horsepower Needed (2 b.h.p. per ton per day) For blanching only.		80 b. h. p.	
Approximate Cost of Boiler if Operated at Rated Capacity		\$5,100.	

# UNIONS

Preparation, Final Inspection and Packaging Equipment, and  
Labor Requirements

1. Preparation Plant Capable of Handling 3,300 Pounds per Hour

On-premises Basis

Feeding to Preparation line

Peeling

Continuous peeler  
With 3 h.p. motor  
Stand-by batch peeler  
With 1½ h.p. motor

Sorting and Trimming

Belt conveying sorter  
Belt size - 30" x 24"  
With 1½ h.p. motor

Washing

Corrugated drum washer  
Drum size - 24" x 12"  
With 1½ h.p. motor

Slicing

Cutter and slicer  
With 2 h.p. motor

Tray Loading and Stacking

Rollers, scales, and other loading  
equipment are small items.  
These are included in cost of  
accessory equipment. See below

Moving Cars and Drying

Scraping Trays

Scraping done over end of  
conveyor

Final Inspecting

Belt conveying sorter  
Belt size - 30" x 20"  
With 1½ h.p. motor

Packaging and Preparing for  
Shipping

Scales, table and sealing  
equipment

General - Foreman

Helpers, cleanup, wash  
trays, and maintenance

Sub-total

for installation and  
cessory equipment; 50% for  
and plus improvised items.

50%

Total

Equipment Cost per Ton Handled per  
24-Hour Day (Unprepared Basis)

Labor Cost per Pound --  
(14 to 1 overall shrinkage)  
(Based on the labor cost per  
hour;

23 Women @ 60¢ per hour	\$13.80
17 Men @ 75¢ " "	12.75
1 Foreman	<u>1.50</u>
Labor cost per wet pound	
(3,330 lbs)	
Labor cost per dry pound	
(238 lbs)	

POTATOES

Preparation, Final Inspection and Packaging Equipment, and  
Labor Requirements  
In a Dehydration Plant Capable of Handling 3,330 Pounds per Hour

Unprepared Basis

<u>Operation</u>	<u>Description of Equipment</u>	<u>Cost</u>	
Feeding to Preparation Line			2 F
Washing	Corrugated drum washer Drum size - 24" x 12" With 1½ h.p. motor	\$ 1,200.	
Sizing	Rubber spool grader Rolls - 20" wide With ¼ h.p. motor		1 M 250
Peeling	Continuous peeler With 3 h.p. motor Stand-by batch peeler With 1½ h.p. motor	1,100. 600.	
Sorting and Trimming	Belt conveying sorter ) 2 Belt size - 30" x 30" ) needed With 2 h.p. motor	2,300	
Stripping	Strip cutter and slicer With 2 h.p. motor	700.	
Spreading on Blancher Belt			2 F
Washing	Sprays on front end of blancher - Included in blancher cost.		
Blanching, 4 Minutes - Loading on blancher belt, two pounds per square foot.	Wire belt blancher Overall length - 34" Covered area - 42" x 25" With 2 h.p. motor	2,000.	
Tray Loading and Stacking	Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment See below.		3 M
Moving Cars and Drying			2 M
Scraping Trays	Scraping done over end of conveyor		4 M
Final Inspecting	Belt conveying sorter Belt size - 30" x 20" With 1½ h.p. motor		1 M



POULTRY (continued)

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>
Packaging and Preparing for shipping	Scales, table, and sealing equipment
General - Foreman Helpers, cleanup, washing trays, and maintenance	
Sub-total	
Add 40% for installation and accessory equipment; 50% for same plus improvised items.	50%
Total	
Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis)	
Labor Cost per Pound - (7 to 1 overall shrinkage ratio) (Based on the labor cost per hour)	50 Women @ 60¢ per hour \$30.00 20 Men @ 75¢ " " 15.00 1 Foreman 1.00 Labor cost per wet pound (3,330 lbs) Labor cost per dry pound (475 lbs)
Steam Generating - Approximate Boiler Horsepower Needed - (2 b.h.p. per ton per day) For blancher only. Approximate Cost of Boiler if Operated at Rated Capacity	80 b.h.p.

# SWEET POTATOES

Preparation, Final Inspection and Packaging Equipment, and  
Labor Requirements  
for a Preparation Plant Capable of Handling 3,330 Pounds per Hour

## Unprepared Basis

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
Feeding to Preparation Line			2 M
Washing	Corrugated drum washer Drum size - 24" x 12' With 1½ h.p. motor	\$1,200.	
Scalding, 10 Minutes in Boiling Water	Continuous hot water scalding Tank - 24" x 14' With 1½ h.p. motor	1,200.	
	Continuous peeler With 3 h.p. motor	1,100.	
	Stand-by batch peeler With 1½ h.p. motor	600.	1 M
Sorting and Grading	Belt conveying sorter Belt size - 30" x 36' With 2 h.p. motor	1,500.	
Blanching	Cutter and slicer With 2 h.p. motor	700.	
Blanching			2 M
	Sprays on front end of blancher - Included in blancher cost.		
Blanching, 6 Minutes - Loading on blancher belt, two pounds per square foot.	Wire belt blancher Overall length - 50' Covered area - 42" x 40' With 2 h.p. motor	2,700.	
Bag Loading and Stacking	Rollers, scales, and other loading equipment are small items, being included as accessory equipment.		
Bagging Cars and Drying			
	Scraping done over end of conveyor		4 M
	Belt conveying sorter Belt size - 30" x 20' With 1½ h.p. motor		

# SWEET POTATOES (continued)

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Rate</u>
Packaging and Preparing for Shipping	Scales, table, and sealing equipment	\$ 150.	37
General - Foreman Helpers, cleanup, washing trays, and maintenance			10
Sub-total		\$9,900.	100
Add 40% for installation and accessory equipment; 50% for same plus improvised items.	90%	4,950.	
Total		<u>\$14,850.</u>	
Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis)		<u>1.31.</u>	
Labor Cost per Pound -- (4½ to 1 overall shrinkage ratio) (Based on the labor cost per hour)	34 Women @ 60¢ per hour \$20.40 20 Men @ 75¢ " " 15.00 1 Foreman 1.50 \$ 36.90		
	Labor cost per wet pound (3,330 lbs)		1.09
	Labor cost per dry pound (740 lbs)		1.88
Steam Generating -- Approximate Boiler Horsepower Needed -- (3 b.h.p. per ton per day) For scalding and blanching only.	120 b.h.p.		
Approximate Cost of Boiler if Operated at Rated Capacity		\$7,000.	

# TURNIPS

Preparation, Final Inspection and Packaging Equipment, and  
Labor Requirements

In Preparation from Capsule of Turnips 1,000 pounds per hour

## Unprepared Basis

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	
Feeding to Preparation Line			
Washing	Corrugated drum washer Drum size - 24" x 12" With 1½ h.p. motor	\$1,200	
Peeling	Continuous peeler With 3 h.p. motor Stand-by batch peeler With 1½ h.p. motor	1,100. 600.	
Topping and Trimming	Belt conveying sorter Belt size - 30" x 27" With 2 h.p. motor	1,050.	18 F
Slicing	Cutter and slicer With 2 h.p. motor	700.	
Spreading on Blancher Belt			2 F
Washing	Sprays on front end of blancher - Included in blancher cost.		
Blanching, 4 Minutes - Loading on blancher belt, two pounds per square foot.	Wire belt blancher Overall length - 37' Covered area - 42" x 28" With 2 h.p. motor	2,100.	
Tray loading and Stacking	Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below.		2 F 3 M
Moving Cars and Drying			
Scraping Trays	Scraping done over end of conveyor		
Final Inspecting	Belt conveying sorter Belt size - 30" x 20" With 1½ h.p. motor	900.	



TURNIPS (continued)

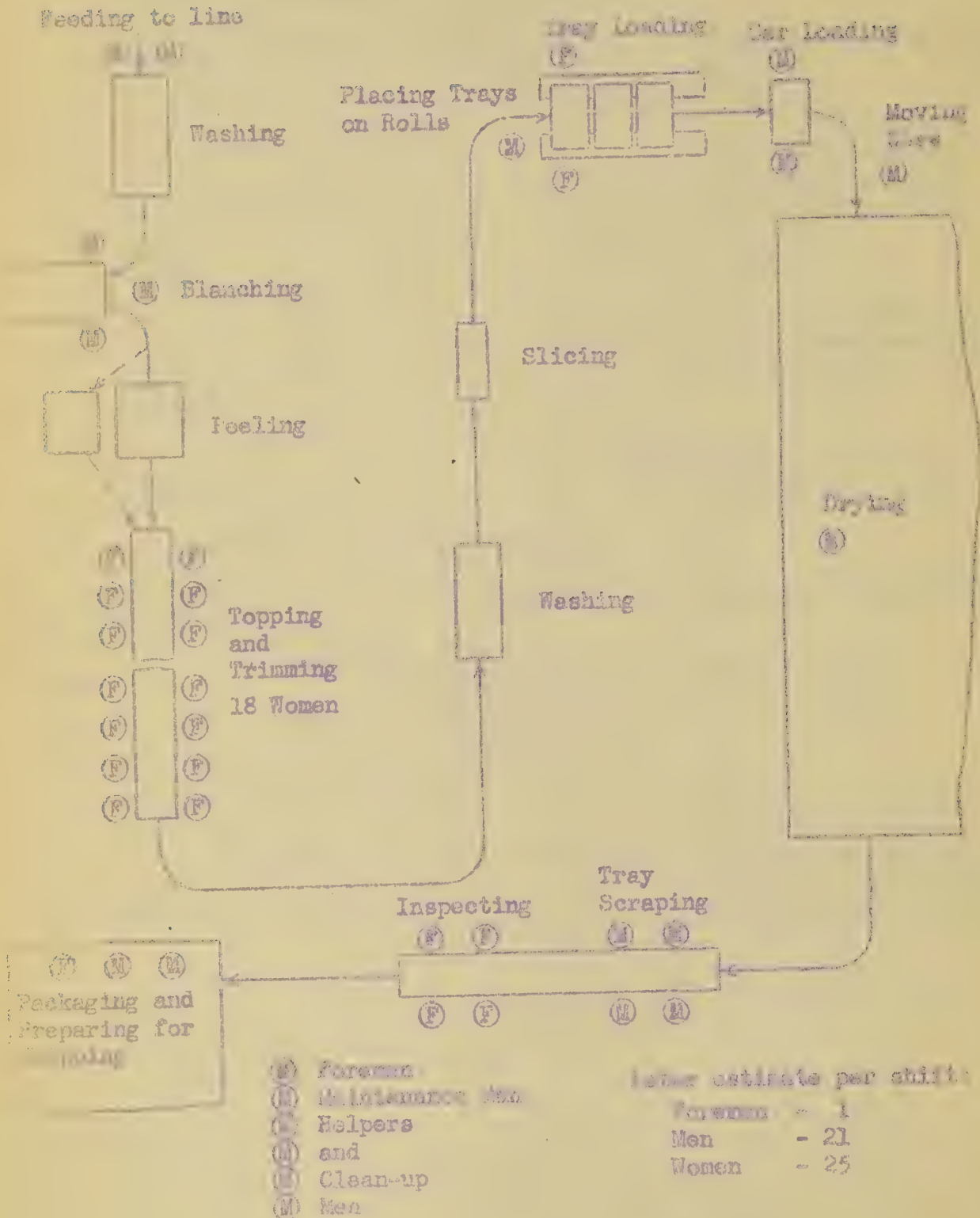
<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
Packaging and Preparing for Shipping	Scales, table, and sealing equipment	\$ 150.	2 M 3 M
General - Foreman Helpers, cleanup, washing trays, and maintenance			1 M 5 M
Sub-total		\$7,800.	
Add 40% for installation and accessory equipment; 50% for same plus improvised items.	50%	3,900.	
Total		<u>\$11,700.</u>	
Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis)		<u>\$ 293.</u>	
Labor Cost per Pound - (10 to 1 overall shrinkage ratio)	28 Women @ 60¢ per hour \$16.80 19 Men @ 75¢ " " 14.25 1 Foreman 1.50	<u>\$ 32.55</u>	
(Based on the labor cost per hour)	Labor cost per wet pound (3,330 lbs)	0.98¢	
	Labor cost per dry pound (333 lbs)	9.8 ¢	
Steam Generating - Approximate Boiler Horsepower Needed - (2 b.h.p. per ton per day) For blancher only.	80 b.h.p.		
Approximate Cost of Boiler if Operated at Rated Capacity		\$5,100.	

SNETS

# DEHYDRATION FLOW SHEET

3330 Pounds per Hour

Unprepared Basis

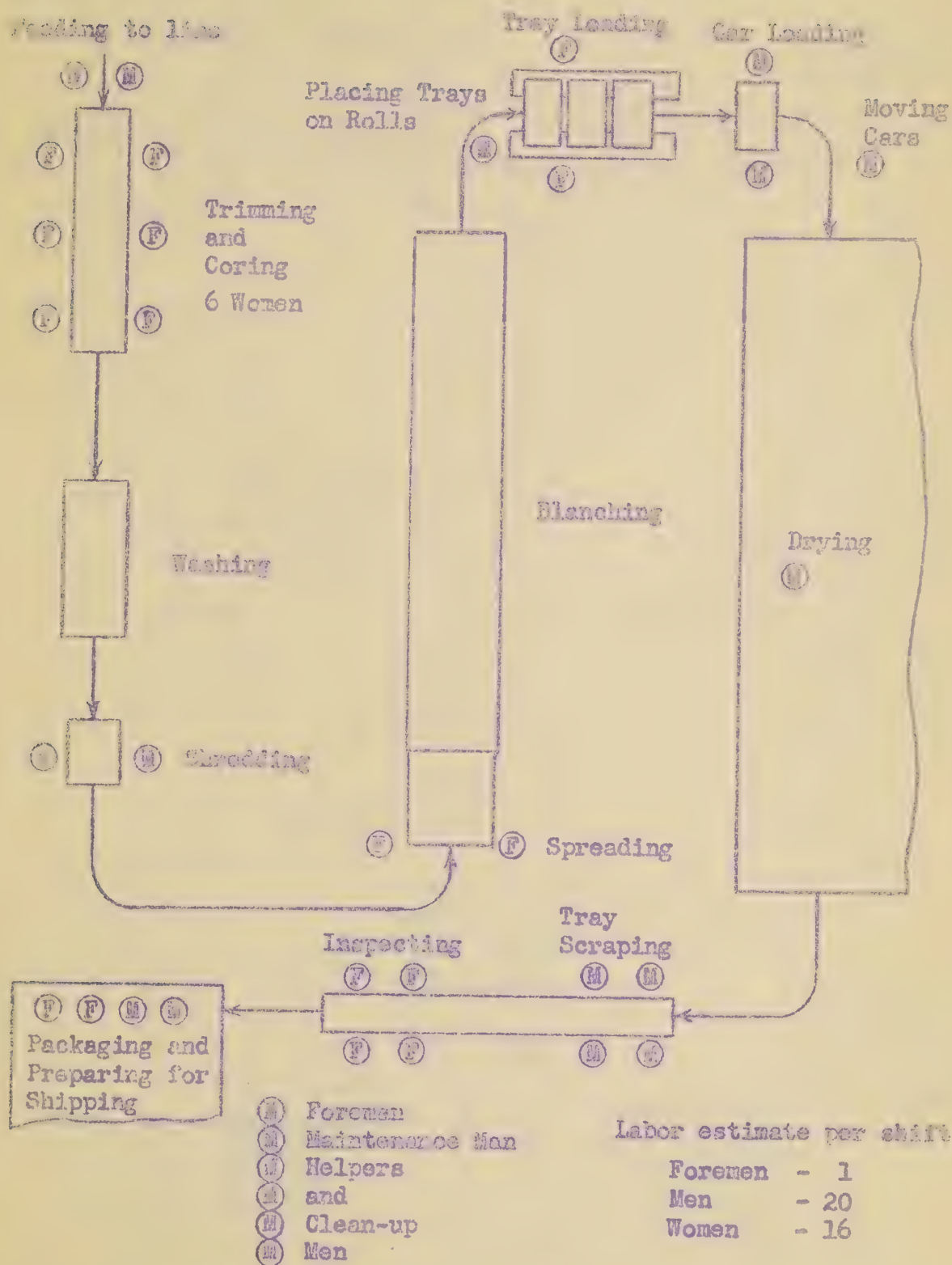


Prepared by the Dehydration Committee,  
Bureau of Agricultural Chemistry and  
of Animal Products, August 1962

# DEHYDRATION FLOW SHEET

3330 Pounds per Hour

Unprepared Basis

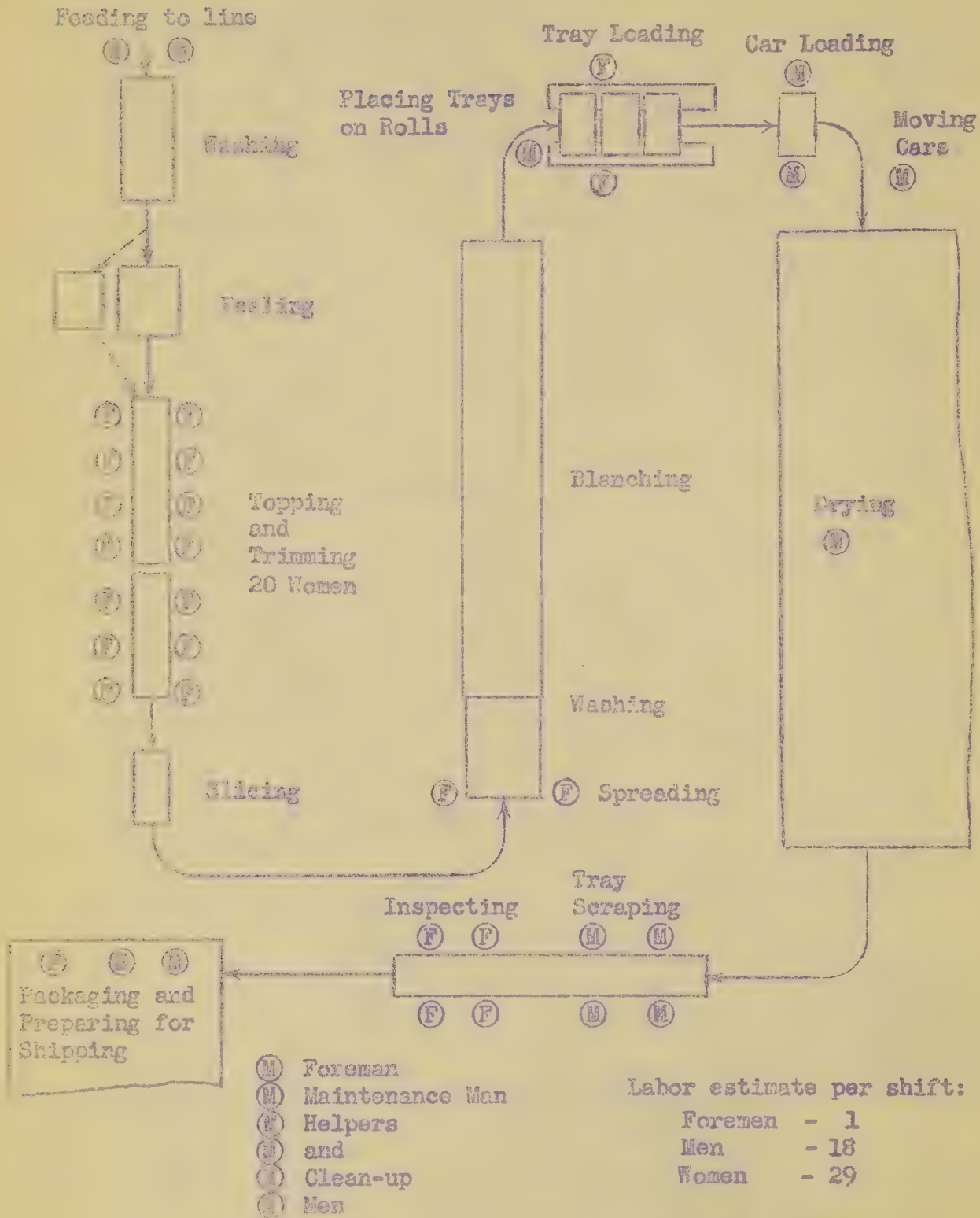


# CARROTS

## DEHYDRATION FLOW SHEET

3330 Pounds per Hour

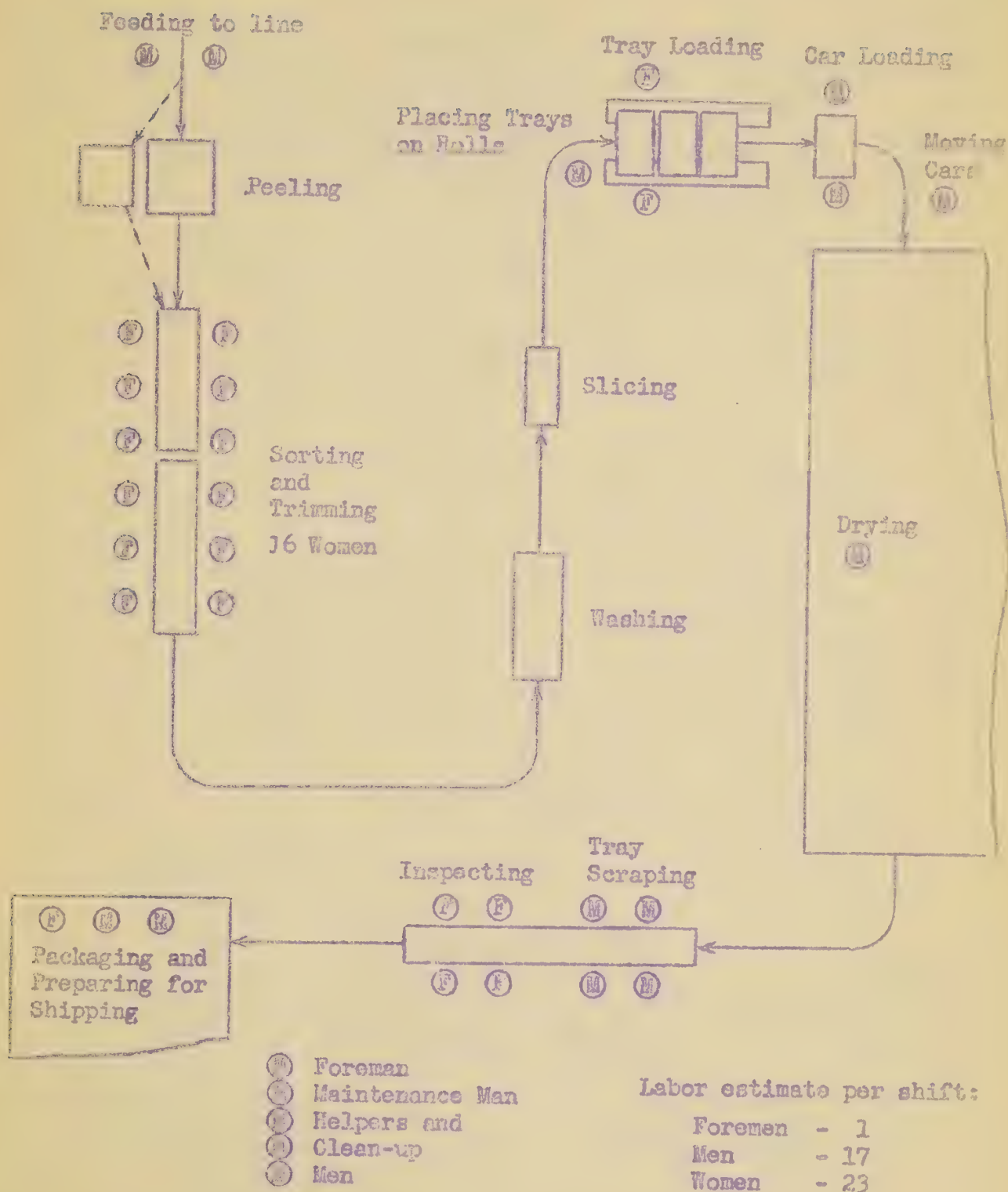
Unprepared Basis



Prepared by the Dehydration Committee,  
Bureau of Agricultural Chemistry and  
Engineering, United States Department  
of Agriculture, August 1942.

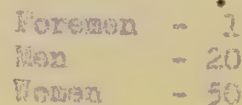


3330 Pounds per Hour  
Unprepared Basis



Prepared by the Dehydration Committee,  
Bureau of Agricultural Chemistry and  
Engineering, United States Department  
of Agriculture, August 1942.

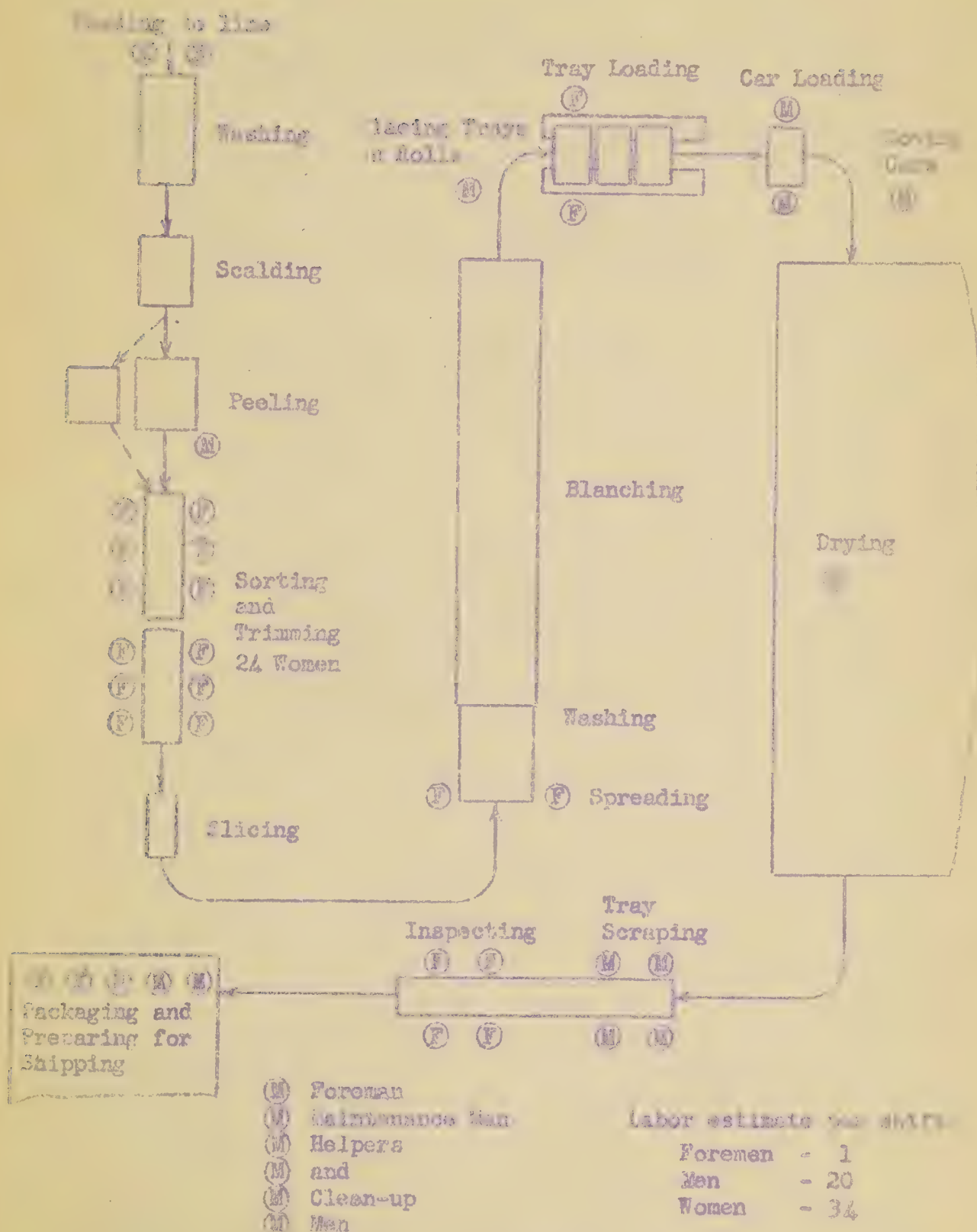
## Unprepared Basis



# DEHYDRATION PLANT SKETCH

330 Pounds per Hour

Unprepared Basis



Prepared by the Dehydration Committee,  
Bureau of Agricultural Chemistry and  
Engineering, United States Department  
of Agriculture, August 1942.

1. The first group of people who are interested in the study of the history of the world are the historians. They are people who study the past and try to understand what happened and why it happened. They use a variety of sources, including books, documents, and artifacts, to reconstruct the past. They also try to understand the people who lived in the past and how they thought and felt. Historians are interested in the history of the world because it helps us to understand the world we live in today.

3330 Pounds per Hour

## Unprepared Basis

Prepared by the Dehydration Committee,  
Bureau of Agricultural Chemistry and  
Engineering, United States Department  
of Agriculture, August 1912



If further detailed information is  
desired, inquiries should be addressed  
to:

The Dehydration Committee  
Bureau of Agricultural Chemistry  
and Engineering  
U. S. Department of Agriculture  
Washington, D. C.

or to

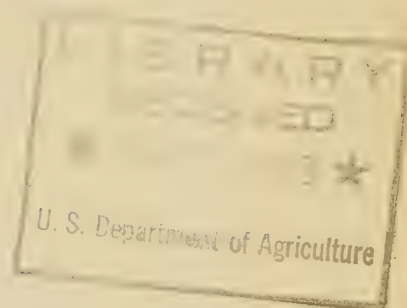
The Dehydration Committee  
Bureau of Agricultural Chemistry  
and Engineering  
U. S. Department of Agriculture  
800 Buchanan Street  
Albany, California



Dehydration Committee  
Bureau of Agricultural Chemistry and Engineering  
U. S. Department of Agriculture

ESTIMATES OF EQUIPMENT COSTS AND LABOR REQUIREMENTS  
IN  
VEGETABLE DEHYDRATION

Plant Capacity--8,330 Pounds Per Hour  
(Unprepared Basis)



Notes:

Preparation, final inspection and packaging equipment are the only types of equipment considered in this report. All labor requirements except clerical and shipping are included.

August 1942





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Preparation, Final Inspection, and Packaging Equipment,  
and Labor Requirements in  
Vegetable Dehydration at a Plant Capacity of 6,000 Pounds per Hour  
Unprepared Basis

This discussion deals with the labor requirements and cost of preparation and packaging equipment in dehydration plants capable of handling 6,000 pounds per hour, unprepared basis, or 100 tons per 24-hour day. The vegetables considered are:

Table Beets  
Cabbage

Carrots  
Onions  
Potatoes

Sweet Potatoes (Yams)  
Turnips (Rutabagas)

Costs of equipment and labor for vegetable drying are subject to wide variation. The ability to improvise certain items may permit substantial savings in plant investment as compared to a plant using standard cannery equipment. Proper plant layout may even eliminate some items. However, due to the large quantities of vegetables passing each point in the operating cycle, it must be recognized that any improvised equipment will have to be extremely rugged.

The balance between labor and machinery is a very important factor. The initial cost of a labor-saving machine may be large, but the labor cost saved may be much larger than capital and operating charges on the machine. Relative availability of labor and machinery may determine the proportions of labor and machine operation in the plant.

Equipment listed herein and indicated methods of operation are intended to be merely suggestive. Other items of equipment as well as other operating procedures may be equally satisfactory or even better. For instance, mechanical abrasive peelers have been suggested. Ice peeling, if permitted by purchase specifications, may be preferable on carrots, potatoes, and other hard root vegetables. Other peeling methods, for example, carbonization by flame or radiant heat, followed by vigorous scrubbing, have also shown promise on an experimental basis. Carrots, turnips, and beets are shown as being peeled before topping. Under certain conditions it may be advisable to do the topping before peeling and the trimming after peeling. Standard abrasive peelers have not proven entirely satisfactory on onions. Operators have adopted various expedients to overcome this difficulty.

Costs and descriptions of equipment are based upon prices and information from established manufacturers in this field. The labor set-ups shown are based upon cannery operations and the operations of present commercial dehydrators. They will vary appreciably from plant to plant. If the items of equipment or sequence and methods of operations are different from those given here, the labor set-up must be modified accordingly.



The accompanying tables show only major items of equipment needed in the preparation of vegetables for drying and in the final inspection and packaging of the dry product. It is recognized that elevators and conveyors may be major items of cost. They have not been specifically included, except in two special instances, because considerable improvement will usually be done by the plant operator in the installation of these items of equipment or in the arrangement of other equipment so as to eliminate the necessity for their use. A part of the allowance for installation and accessory equipment is intended for this purpose.

Some peelers have the tendency to over-peel smaller size vegetables and inadequately peel larger ones. Hence it is preferable to put only one size through the peelers at a time. This involves the use of a grader or sizer or the purchase of pre-graded vegetables. A make-shift arrangement in a plant this size would not be good economy.

A water spray at the beginning of the blancher belt is quite satisfactory in washing the diced, sliced, or stripped vegetables. This will eliminate the necessity of purchasing a separate washer. Such a water spray at the front end of the blancher belt tends to prevent excessive humidity in the preparation room by condensing steam escaping from this end of the blancher.

The amount of steam necessary for blanching will vary from plant to plant depending upon losses from the blancher and care in the avoidance of steam wastage. The range may be from 1 to 3 boiler horsepower for each ton of unprepared vegetables handled per 24-hour period. Except for beets and sweet potatoes, a requirement of 2-boiler horsepower per ton per day has been assumed. Due to retort blanching used for beets, a slightly larger amount is considered necessary. Sweet potatoes are peeled as well as blanched. Due to this double heating, they require somewhat more steam capacity. The plant operator can lessen the investment in steam boilers by insuring proper plant operation to minimize the steam losses and by operating the steam boiler above its rated capacity.

Since continuous peelers will need periodic cleaning, provision has been made for a batch peeler to carry the load while one of the peelers is out of action and also to handle odd sizes during normal operation. Two slicers or strippers have also been listed. Other than for these two operations, the line-up provides for no stand-by equipment. Where there is a possibility that the stopping of any machine will interrupt the continuous flow of the product through the plant, some means of substitution operation should be available or there should be storage facilities for the product so that it will not deteriorate while standing. Due to the large investment in raw material in a plant this size, the possibility



such blanchers very common. It may be justified in one or almost all of the major items of equipment. Two blanching belts are preferable to one, both from an operating standpoint and because of the possibility of a breakdown. It may even be desirable to provide two smaller blanchers instead of one large one.

Simultaneously or if the vegetable were to be prepared in two forms. The machines listed are high-grade machines with automatic controls. For the reason that they are operated with blanchers and blanching plants. Availability is the key note in these items. The cost of single items of equipment is more important when other items of investment are considered; namely, raw material, labor, and total plant investment.

As far as required vegetable has been considered. Preparation of vegetables in other forms will necessitate the installation of other types of equipment and will usually entail an increase in labor. The labor set-up may also be affected to some extent by resultant differences in blancher loading, tray loading, and drying time.

In the case of onions, at least a portion of the product will usually be converted to a powder form. It is necessary to conduct this operation in a room where the equipment will have to be installed for this purpose. It is advantageous to conduct all onion processing operations in an air-conditioned room at low humidity.

Cost of packaging equipment is based on the assumed use of 5-gallon cans. Manual practice has been to solder the top after filling the can. All this can be done by a can sealer which for the gas, relatively inexpensive, and the equipment, and which are the main items needed for this type of packaging. Other types of packaging might involve a larger capital investment. Automatic can sealers have been recently introduced. These use a plastic sealing material under the edge of the lid which eliminates the necessity for soldering. An increased capital investment is ordinarily involved in the use of the automatic can sealer since the machines are leased to the user. Equipment operating costs will be higher, due to the rental paid, but these will be more than offset by lower labor costs.

The blanching belts included are straight single-unit belts. However, if the blanching belts will involve higher equipment costs on the blanching and trimming line. Their use may, however, result in reduced labor costs, especially in the larger size plants.

Provision for waste disposal equipment has been made in these estimated costs. Since disposal of waste is a very important and sometimes

water factor, it cannot be overlooked in setting up a plant, especially where the waste may amount to 25 tons per day. Each plant may have its own method of waste disposal, but it is probable that in the case of onions and sweet potatoes, the most common method will involve carrying of wastes from the plant by water. This will necessitate a method of separating suspended solids from the water by screening, settling, or otherwise. These solids may be hauled away, incinerated, or processed for byproduct values. The liquid effluent may be run down a sewer, a running stream, or to other places of disposal. Other vegetable wastes may be hauled away, burned, or treated for byproduct recovery, but will usually involve a less serious sewerage problem. All of these methods will be subject to sanitary regulation. Due to the many factors involved, no attempt is being made at this time to estimate the cost of such equipment. Economical disposal of preparation wastes will usually require some ingenuity on the part of plant operators.

Estimates that installation costs will amount to from 10 to 20% of purchase price of the machinery. Valves, piping, wiring, trucks, scales, tools, and other accessory equipment plus some allowance for unclassified items may amount to an additional 30 to 40%. Together they make a total of about 50% to be added to the purchase price to cover costs of installation and accessory items.

The number of employees needed to operate a plant is by no means fixed. The use of conveyors, chutes, elevators, and other automatic equipment will reduce the need for employees to handle the material.

When the prepared material on trays for drying, it is necessary to spread it uniformly over the surface of the trays. This allows for circulation of air to all of the material and avoids lumps which will dry unevenly. An automatic device for spreading the material on trays or of tray conveyors will reduce the number of employees needed for spreading. Automatic spreading on the blancher belts will give the same results.

The number of women that are employed on scrubbing and trimming belts will have a direct effect on the operation of the plant. As the number of employees increases, more time will be spent on each potato or other vegetable, resulting in a better dried product. Careful trimming will decrease the amount of dried material discarded. At the final inspection, decrease the likelihood of product rejection. It will probably decrease the number of women needed for the final inspection. There will, however, be an optimum point for the most economical operation of the plant in obtaining an acceptable product.

The material cost and labor cost per pound of dry product are directly



is heavily influenced by preparation losses. A saving of even 5% in preparation losses (i.e. a decrease from 25% to 20% preparation loss) may justify the wages for a number of additional women per shift in the sorting and blending hall. Improvement in the quality of the final product due to additional care in preparation and decrease in waste disposal cost may also be deciding factors in determining whether an increase in the number of sorters and trimmers is warranted.

It is assumed that the extra men shown on the accompanying charts will assist in actual processing of the material, in care and operation of the equipment, and in removal of wastes from the plant.

The tables and charts assume continuous operation of the plant in three 8-hour shifts. Since actual working time in an 8-hour shift may be only 7 hours, the indicated hourly capacities are only an average of quantities handled during the entire 8 hours. Quantities handled in any one hour of actual operation will have to be slightly higher if the stated rate of production is to be maintained. The number of employees indicated should as a rule be sufficient to cover this difference.





# SUMMARY OF COSTS

Preparation, Final Inspection, and Packaging Equipment,  
and Labor Requirements in  
Vegetable Dehydration at a Plant Capacity of 6,330 Pounds per Hour

Unprepared Basis

Vegetable	Shrinkage Ratio	Equipment Cost			Labor Cost	
		Total	Wet (Unpre- pared)	Dry	Wet (Unpre- pared)	Dry
		\$	\$	\$	\$	\$
Whole Peas	13 to 1	19,575	196	2,545	0.26	3.3
Chickpeas	12 to 1	18,875	192	2,605	0.54	10.7
Lentils	10 to 1	22,425	224	2,242	0.77	7.7
Beans	14 to 1	13,875	139	1,942	0.67	9.4
Butterbeans	7 to 1	23,425	254	1,730	1.17	8.2
Split Peas	4 1/2 to 1	27,225	272	1,225	0.88	1.5
Beans	16 to 1	22,125	221	2,312	0.77	7.7

1/ Equipment cost per ton handled per 24-hour day.

Capacities per Unit of Time  
In a Vegetable Dehydration Plant  
Capable of Handling 8,330 Pounds per Hour

(Unprepared Basis)

	Beets	Cabbage	Carrots	Onions	Potatoes	Sweet Potatoes (Yams)	Turnips
<u>Form Prepared</u>	Slices	Shreds	Slices	Slices	Strips	Slices	Slices
<u>Unprepared basis:</u>							
Tons per 24-hour day	100	100	100	100	100	100	100
Pounds per 24-hour day	200,000	200,000	200,000	200,000	200,000	200,000	200,000
Pounds per hour	8,330	8,330	8,330	8,330	8,330	8,330	8,330
Pounds per minute	140	140	140	140	140	140	140
Number of women coring		14					
Pounds per woman per hour		595					
Pounds per woman per minute		10					
Number of retorts	2						
Blanching time in minutes	10						
Minutes per charge per retort -							
loading, blanching & unloading	24						
Charges per hour	5						
Pounds per charge	1,670						
Number of crates per charge	3						
Pounds per car or crate	560						
Charges per car	5						
Pounds per tray	112						
<u>Prepared basis:</u>							
Preparation loss	30%	25%	25%	15%	25%	25%	20%
per 24-hour day	70	75	75	85	75	75	80
per 24-hour day	140,000	150,000	150,000	170,000	150,000	150,000	160,000
per hour	5,830	6,250	6,250	7,080	6,250	6,250	6,670
per minute	97	105	105	120	105	105	110
Number of women sorting,							
loading and trimming	46		50	40	100	60	46
per woman per hour	125		125	175	65	105	145
per woman per minute	2.1		2.1	3.0	1.0	1.7	2.4
<u>Assumed blancher loading -</u>							
Lbs. per square foot		1.5	2.0		2.0	2.0	2.4
Assumed blanching time in minutes		3	4		4	6	4
Pounds in blancher at any one							
time		315	415		415	625	445
Square feet of blancher needed		210	210		210	310	220
<u>Assumed tray loading -</u>							
Lbs. per square foot	1.5	1.2	1.5	1.2	1.5	1.5	1.5
	590	475	590	475	590	590	590

(Unprepared Basis)

1. 1990

	13 to 15	19 to 20	10 to 11	14 to 15	7 to 8	12 to 13	10 to 11
per 24-hour day	15,380	10,530	20,000	14,290	28,970	24,410	20,000
per hour	640	440	830	600	1,190	1,450	1,100
per minute	11	7.3	14	10	20	24	18
per 5-gallon can	10	5	14	9	10	12	10
cost per 24-hour day	1,540	2,110	1,430	1,590	2,860	1,440	1,400
cost per hour	64	88	60	66	120	144	110
cost per can	0.9	0.7	1.0	0.9	0.5	0.6	0.5



TABLE BEETS  
Preparation, Final Inspection and Packaging Equipment, and  
Labor Requirements  
In a Dehydration Plant Capable of Handling 8,330 Pounds per Hour

Unprepared Basis

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
Feeding to Preparation Line			3 M
Washing	Corrugated drum washer Drum size - 36" x 12' With 2 h.p. motor	\$1,400.	
Blanching - 10 minutes at 5 pounds pressure in retorts	Horizontal retort - 3 car capacity Cylinder - 54" x 10' (2 needed) 60 trays and 12 retort cars	2,200. 500.	4 M
Peeling	Continuous peeler ) 2 With 3 h.p. motor ) needed Stand-by batch peeler With 1½ h.p. motor	2,200. 600.	
Grading and Trimming	Belt conveying sorter ) Belt size - 30" x 35" ) 2 with 2 h.p. motor ) needed	2,500.	46 F
Washing	Washer elevator with water boot and sprays Draper width - 30" With 1½ h.p. motor	900.	
Cutting	Cutter and slicer ) 2 With 2 h.p. motor ) needed	1,400.	
Final Loading and Stacking	Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below		4 F 4 M
Final Loading Cars and Drying			3 M
Scraping Trays	Scraping done over end of conveyor		7 M
Final Inspecting	Belt conveying sorter Belt size - 30" x 30" With 2 h.p. motor	1,150.	10 F



# Plant and Equipment

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	
Packaging and Preparing for shipping	Scales, table, and sealing equipment	200.
General - Foreman Helpers, cleanup, washing trays, and maintenance		
Sub-total		\$13,050.
Add 40% for installation and accessory equipment; 50% for same plus improvised items	50%	6.525
Total		\$19,575.
Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis)		\$
Labor Cost per Pound - (13 to 1 overall shrinkage ratio) (Based on the labor cost per hour)	62 Women @ 60¢ per hour \$37.20 33 Men @ 75¢ " " 24.75 1 Foreman 1.50 Labor cost per wet pound (8,330 lbs) Labor cost per dry pound (641 lbs)	
Steam Generating - Approximate Boiler Horsepower Needed --(2½ b.h.p. per ton per day) For blancher only. Approximate Cost of Boiler if Operated at Rated Capacity	250 b.h.p.	\$12,500.

# CABBAGE

Preparation, Final Inspection and Packaging Equipment, and  
Labor Requirements  
In a Dehydration Plant Capable of Handling 8,330 Pounds per Hour

Unprepared Basis

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
Feeding to Preparation Line	Belt conveyor Belt size - 18" x 100' With 5 h.p. motor	\$2,100.	3 M
Trimming and Coring	Belt conveying sorter Belt size - 30" x 24" With 1½ h.p. motor 14 Improvised cabbage corers With 2 h.p. motor located over belt	1,000. 400.	14 M
Washing	Corrugated drum washer Drum size - 36" x 12" With 2 h.p. motor	1,400.	
Shredding	Kraut cutter ) 2 32½" disc ) With 2 h.p. motor ) needed	1,200.	2 M
Spreading on Blancher Belt			2 F
Blanching, 3 Minutes - Loading on blancher belt, 1½ pounds per square foot.	Wire belt blancher Overall length - 52' Covered area - 60" x 42' With 3 h.p. motor	5,200.	
Tray Loading and Stacking	Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below.		4 F 4 M
Moving Cans and drying			3 M
Wrapping Trays	Scrapping done over end of conveyor		
Final Inspecting	Belt conveying sorter Belt size - 30" x 30" With 2 h.p. motor		

equipment

... and maintenance

Sub-total

\$12.650

Add 40% for installation and accessory equipment; 50% for same plus improvised items.

6,300 mi.

Total

\$18,975.

Equipment Cost per Ton Handled per  
24-Hour Day - (Unprepared Basis)

190

Labor Cost per Pound -

50¢ per hour \$19.80

(19 to 1 overall shrinkage ratio)

22 1952 @ 75¢ " " 24.00

1. 1000000	1.50
------------	------

ased on the labor cost per

*[Faint, illegible handwritten notes]*

1. 2000

1900-1901

### Steam Generating - Approximate

Boiler Horsepower Needed - (2 b.h.p.)

Approximate Cost of Boiler if

Operated at Rated Capacity

# CARROTS

Preparation, Final Inspection and Packaging Equipment, and  
Labor Requirements  
In a Dehydration Plant Capable of Handling 8,330 Pounds per Hour

Unprepared Basis

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
Feeding to Preparation Line			3 M
Washing	Corrugated drum washer Drum size - 36" x 12" With 2 h.p. motor	\$1,400.	
Peeling	Continuous peeler ) 2 With 3 h.p. motor ) needed Stand-by batch peeler With 1½ h.p. motor	2,200. 600.	
Topping and Trimming	Belt conveying sorter ) 2 Belt size - 30" x 40") needed With 2 h.p. motor	2,800.	50 F
Slicing	Cutter and slicer ) 2 With 2 h.p. motor) needed	1,400.	
Spreading on Blancher Belt			2 F
Flushing	Sprays on front end of blancher. Included in blancher cost.		
Blanching, 4 Minutes - Loading on Blancher belt, two pounds per square foot	Wire belt blancher Overall length - 52' Covered area - 60" x 42' With 3 h.p. motor	5,200.	
Loading and Stacking	Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below.		4 F
Rolling Cans and Drying			3 M
Sealing Trays	Scraping done over end of conveyor		9 M
Final Inspecting	Belt conveying sorter Belt size - 30" x 30" With 2 h.p. motor		



Operation	Description of Equipment	Cost
Equipment - preparing for all work	Scales, table, and sealing equipment	200.
General - Foreman Helpers, cleanup, tray washing, and maintenance		
Sub-total		\$11,957.
Add 40% for installation and accessory equipment; 50% for same plus improvised items.	50%	7,475.
Total		<u>\$22,425.</u>
Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis)		<u>\$ 224.</u>
Labor Cost per Pound - (10 to 1 overall shrinkage ratio) (Based on the labor cost per hour)	68 Women @ 60¢ per hour \$40.80 29 Men @ 75¢ " " 21.75 1 Foreman 1.50 \$ 64.05	
	Labor cost per wet pound (8,330 lbs)	
	Labor cost per dry pound (833 lbs)	7
Steam Generating - Approximate Boiler Horsepower Needed (1 b.h.p. per ton per day) for blancher only.	200 b.h.p.	
Approximate Cost of Boiler if rated at Rated Capacity		\$10,000.

ONIONS

Preparation, Final Inspection and Packaging Equipment, and  
Labor Requirements  
In a Dehydration Plant Capable of Handling 8,330 Pounds per Hour

Unprepared Basis

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
Feeding to Preparation Line			3 3
Peeling	Continuous peeler ) 2 With 3 h.p. motor ) needed Stand-by batch peeler With 1½ h.p. motor	\$2,200. 600.	
Sorting and Trimming	Belt conveying sorter ) Belt size - 30" x 30" ) 2 With 2 h.p. motor ) needed	2,200.	
Washing	Corrugated drum washer Drum size - 36" x 12" With 2 h.p. motor	1,400.	
Slicing	Cutter and slicer . ) 2 With 2 h.p. motor ) needed	1,400.	
Tray Loading and Stacking	Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below.		4 4
Moving Cars and Drying			3 3
Scraping Trays	Scraping done over end of conveyor		8 3
Final Inspecting	Belt conveying sorter Belt size - 30" x 30" With 2 h.p. motor	1,150.	10 7
Packaging and Preparing for Shipping	Scales, table, and sealing equipment	200.	2 3

(continued)

	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>
General - Foreman Helpers, cleanup, washing trays, and maintenance.		
Sub-total		\$9,250.
40% for installation and accessory equipment; 50% for same plus improvised items	50% -	1,625
Total		<u>\$13,875.</u>
Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis)		<u>\$ 139</u>
Labor Cost per Pound - (14 to 1 overall shrinkage) (Based on the labor cost per hour)	56 Women @ 60¢ per hour \$33.60 28 Men @ 75¢ " " 21.00 1 Foreman 1.00 Labor cost per wet pound (3,390 lbs) 0.67 Labor cost per dry pound (595 lbs) 9.1	

# POTATOES

Preparation, Final Inspection and Packaging Equipment, and  
Labor Requirements  
In a Dehydration Plant Capable of Handling 8,330 Pounds per Hour

## Unprepared Basis

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
Feeding to Preparation Line			3 M
Washing	Corrugated drum washer Drum size - 36" x 12' With 2 h.p. motor	\$1,400.	
Grading	Rubber spool grader Rolls - 20" wide With 1/2 h.p. motor	400.	1 M
Peeling	Continuous peeler ) 2 With 3 h.p. motor ) needed Stand-by batch peeler With 1 1/2 h.p. motor	2,200. 600.	
Sorting and Trimming	Belt conveying sorter Belt size - 30" x 75' ) 2 With 5 h.p. motor ) needed	4,400.	100 F 1 S
Stripping	Strip cutter and slicer ) 2 With 2 h.p. motor ) needed	1,400.	
Spreading on Blancher Belt			2
Washing	Sprays on front end of blancher - Included in blancher cost.		
Blanching, 4 Minutes - loading on Blancher belt, two pounds per square foot.	Wire belt blancher Overall length - 52' Covered area - 60" x 42' With 3 h.p. motor	5,200.	
Tray Loading and Stacking	Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below.		4 F 4 F
Tray Cars and Drying			3 F
Scraping Trays	Scraping done over end of conveyor		
	Belt conveying sorter Belt size - 30" x 30' With 2 h.p. motor	1,150.	1 F



	<u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
Packaging and Preparing for Shipping	Scales, table, and sealing equipment	\$ 200.	3 F 5 H
General - Foreman			1 F
Helpers, cleanup, washing trays, and maintenance			
Sub-total		\$16,900.	
Add 40% for installation and necessary equipment; 50% for same plus improvised items.	50%	<u>8,475.</u>	
Total		<u>\$25,425.</u>	
Equipment Cost per Ton Handled per		<u>\$ 254.</u>	
Labor Cost per Pound -	110 Men @ 60¢ per hour	\$71.40	
(7 to 1 overall shrinkage ratio)	24 Men @ 75¢ " "	24.00	
(Based on the labor cost per	1 Foreman	1.00	
hour)	1 Lady Supervisor	<u>1.00</u>	<u>\$ 97.90</u>
	Labor cost per wet pound		
	(1.130 lbs)		1.130
	Labor cost per dry pound		
	(1.10 lbs)		1.10
Approximate			
Boiler Horsepower Needed -(2 b.h.p.			
per ton per day) For blancher only	200 b.h.p.		
Approximate Cost of Boiler if			
Operated at Rated Capacity		\$10,000.	

# SWEET POTATOES

Preparation, Final Inspection and Packaging Equipment, and  
Labor Requirements  
In a Dehydration Plant Capable of Handling 8,330 Pounds per Hour

## Unprepared Basis

	Equipment	
	Description of Equipment	Cost
Feeding to Preparation Line		
Washing	Corrugated drum washer Drum size - 36" x 12" With 2 h.p. motor	4,100.
Scalding, 10 Minutes in Scalding Water	Continuous hot water scalding Tank - 42" x 20" With 2 h.p. motor	1,400.
Peeling	Continuous peeler ) 2 With 3 h.p. motor ) needed Stand-by batch peeler With 1 1/2 h.p. motor	600
Sorting and Trimming	Belt conveying sorter ) Belt size - 30" x 45" ) 2 With 3 h.p. motor ) needed	3,000.
	Cutter and slicer ) 2 with 2 h.p. motor ) needed	1,400.
Feeding on Blancher Belt		
	Sprays on front end of blancher - included in blancher cost.	
Blanching, 6 Minutes - Loading on blancher belt, two pounds per square foot.	Wire belt blancher Overall length - 73' Covered area - 60" x 63" With 3 h.p. motor	6,200.
Loading and Stacking	Rollers, scales, and other loading equipment are small items, being included as accessory equipment.	
	Belt size - 30" x 30'	

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	
Packaging and Preparing for Shipping	Scales, table, and sealing equipment	
General - Foreman Helpers, cleanup, washing trays, and maintenance		
Sub-total		
Add 40% for installation and necessary equipment; 50% for same plus improvised items.	50%	
Total		
Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis)		\$ 272.
Labor Cost per Pound - (4 1/2 to 1 overall shrinkage ratio) (Based on the labor cost per	79 Women @ 60¢ per hour \$47.40 52 Men @ 75¢ " " 24.00 1 Foreman 1.50 \$ 72.90 Labor cost per wet pound (8,330 lbs) Labor cost per dry pound (1,850 lbs)	
oven Concentrating - Approximate Boiler Horsepower Needed - (3 b.h.p. per ton per day) For scalding and blancher only. Approximate Cost of Boiler if erated at Rated Capacity	300 b.h.p.	\$15,000.

TURNIPS  
Preparation, Final Inspection and Packaging Equipment, and  
Labor Requirements  
In a Dehydration Plant Capable of Handling 8,330 Pounds per Hour

Unprepared Basis

<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>
Preparation Line		
Cashing	Corrugated drum washer Drum size - 36" x 12" With 2 h.p. motor	\$1,400.
Peeling	Continuous peeler ) 2 With 3 h.p. motor ) needed Stand-by batch peeler With 1½ h.p. motor	2,200. 600.
Sorting and Trimming	Belt conveying sorter ) 2 Belt size - 30" x 35' ) needed With 2 h.p. motor )	2,500.
Slicing	Cutter and slicer ) 2 With 2 h.p. motor ) needed	1,400.
Spreading on Blancher Belt		
	Sprays on front end of blancher Included in blancher cost.	
Blanching, 4 Minutes - Loading on blancher belt, two pounds per square foot.	Wire belt blancher Overall length - 55' Covered area - 60" x 45' With 3 h.p. motor	5,300.
Tray Loading and Stacking	Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below.	
Moving Cars and Drying		
	Scraping done over end of conveyor	
	Belt conveying sorter Belt size - 30" x 30' With 2 h.p. motor	1,150.



# TURNIPS (continued)

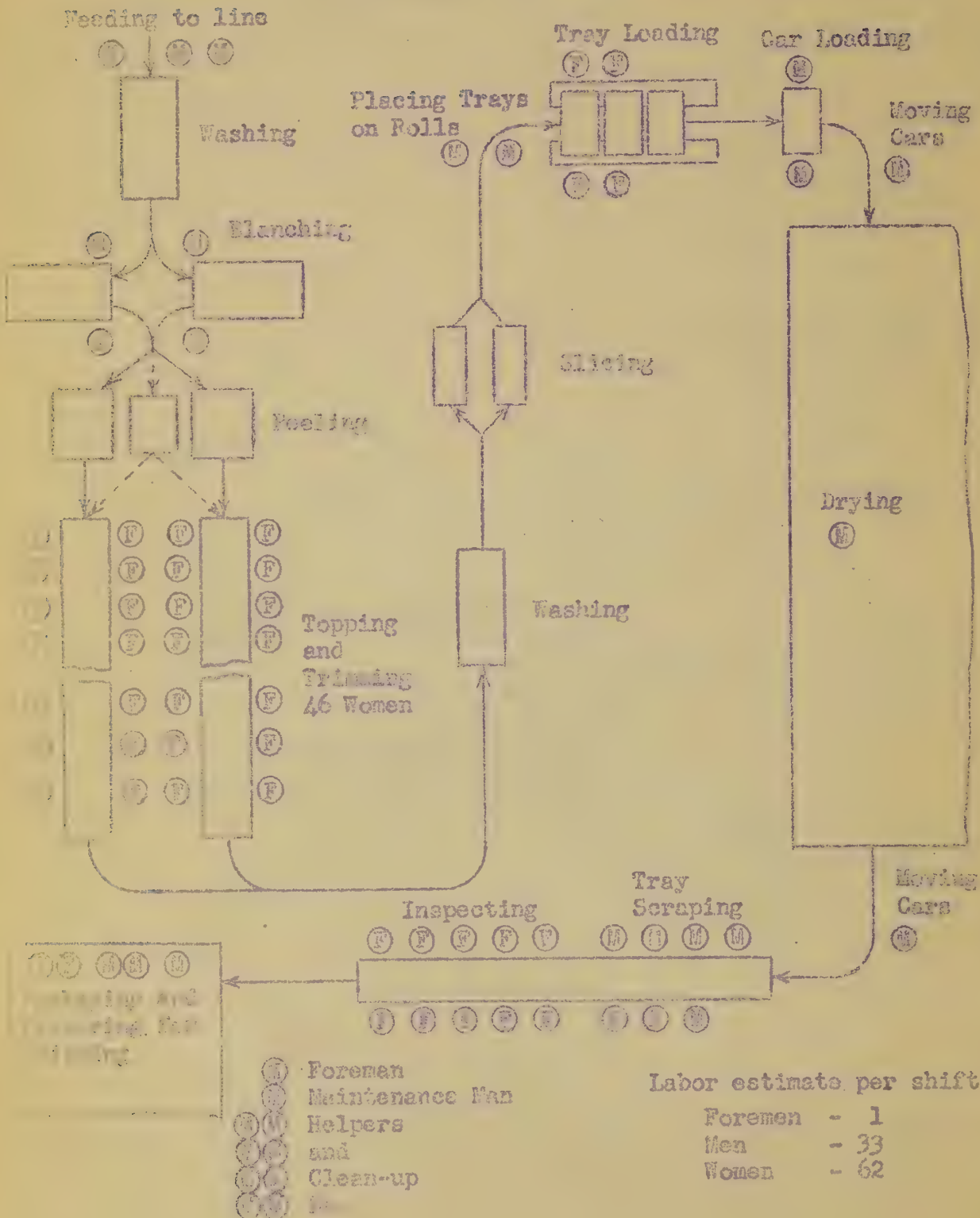
<u>Operation</u>	<u>Equipment</u> <u>Description of Equipment</u>	<u>Cost</u>	<u>Labor</u>
Packaging and Preparing for Shipping	Scales, table, and sealing equipment	\$ 200.	
General - Foreman Helpers, cleanup, washing trays, and maintenance			
Sub-total		\$14,750.	
Add 40% for installation and accessory equipment; 50% for same plus improvised items.	50%	7,375.	
Total		<u>\$22,125.</u>	
Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis)		<u>\$ 221.</u>	
Labor Cost per Pound - (10 to 1 overall shrinkage ratio) (Based on the labor cost per hour)	65 Women @ 60¢ per hour \$39.00 31 Men @ 75¢ " " 23.25 1 Foreman 1.50 \$ 63.75 Labor cost per wet pound (8,330 lbs) Labor cost per dry pound (833 lbs)		0.77 7.7
Steam Generating - Approximate Boiler Horsepower Needed - (2 b.h.p. per ton per day) For blancher only. Approximate Cost of Boiler if Operated at Rated Capacity	200 b.h.p.	\$10,000.	

DEHYDRATION

DEHYDRATION FLOW SHEET

8330 Pounds per Hour

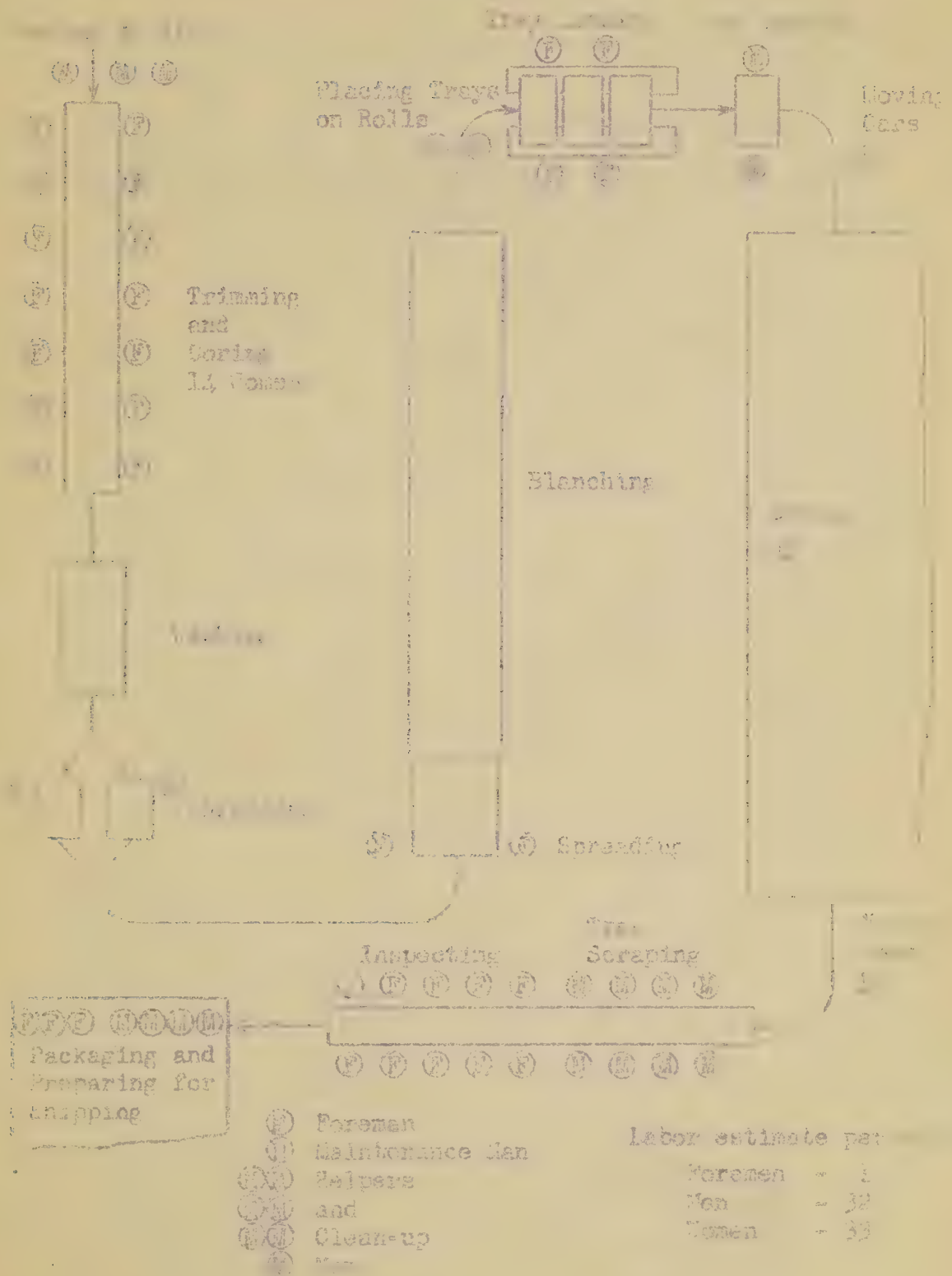
Unprepared Basis



# DEHYDRATION LINE SKETCH

8350 Pounds per Hour

Unpressured Basis

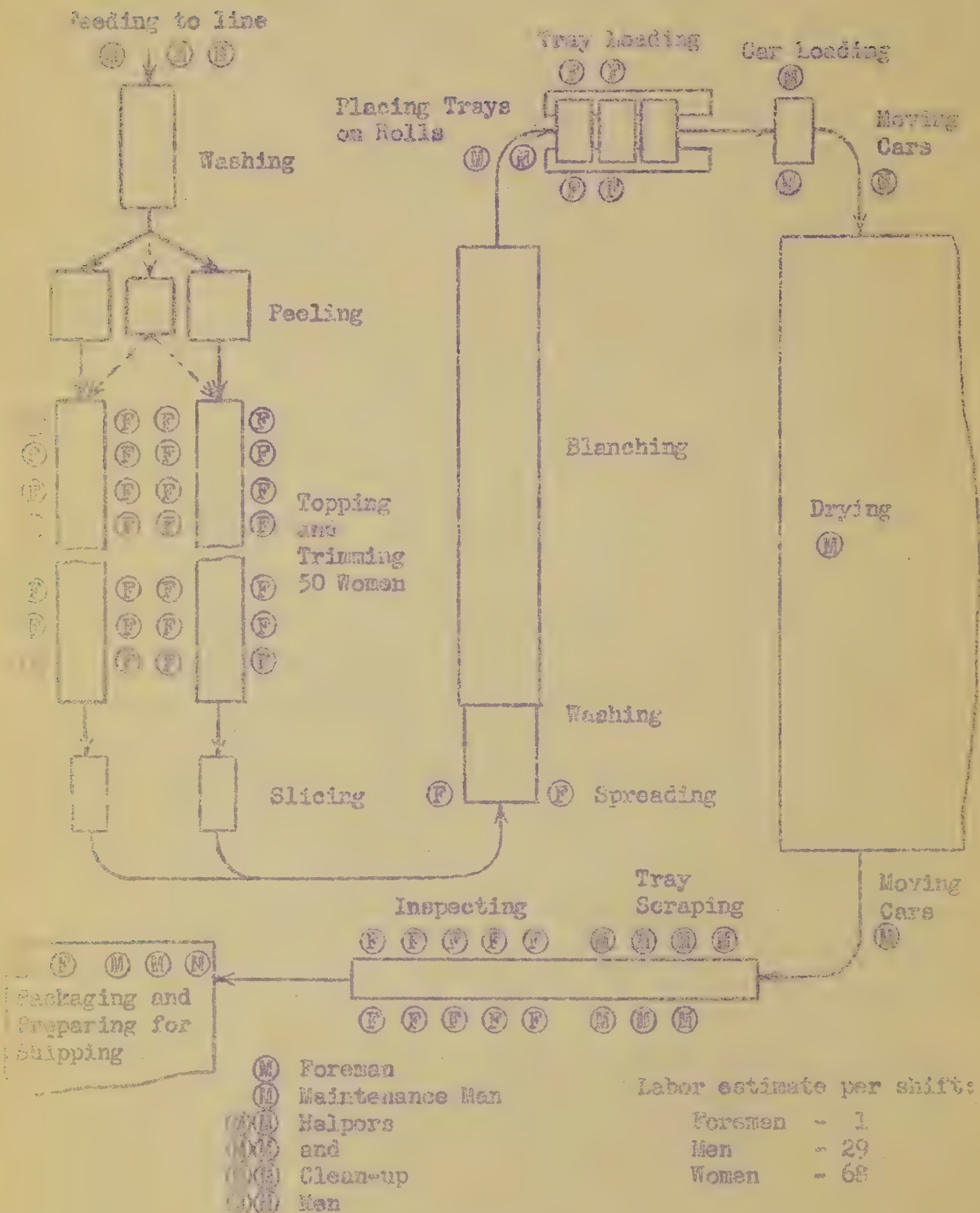


Prepared by the Dehydration Comm.  
Bureau of Agricultural Chemistry  
Engineering, United States Dept.  
of Agriculture, August 1942.

# DEHYDRATION FLOW SHEET

8330 Pounds per Hour

Unprepared Basis



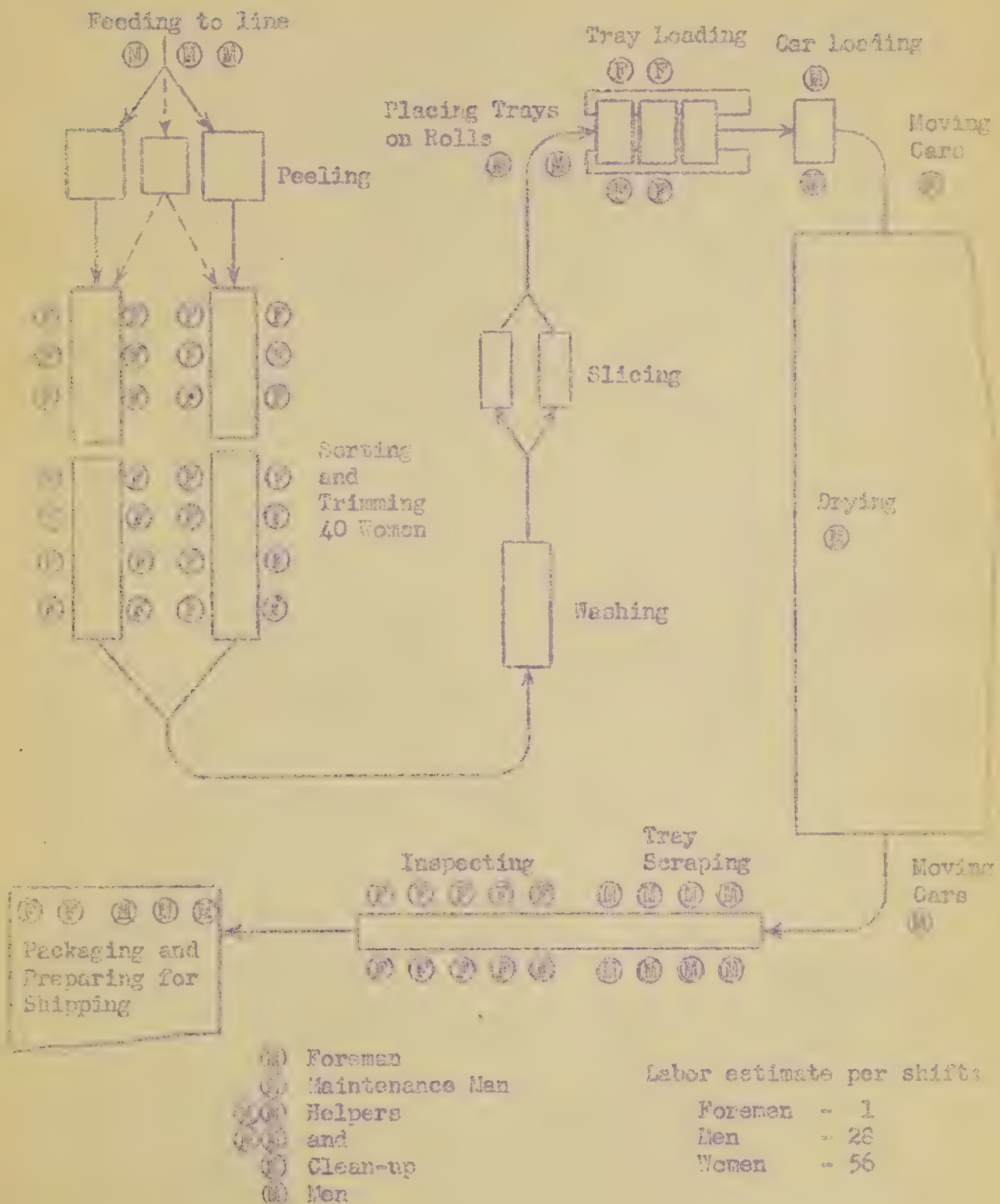
Prepared by the Dehydration Committee,  
Bureau of Agricultural Chemistry and  
Engineering, United States Department  
of Agriculture, August 1942.



# ON FLOW SHEET

2330 Pounds per Hour

Unprepared Basis

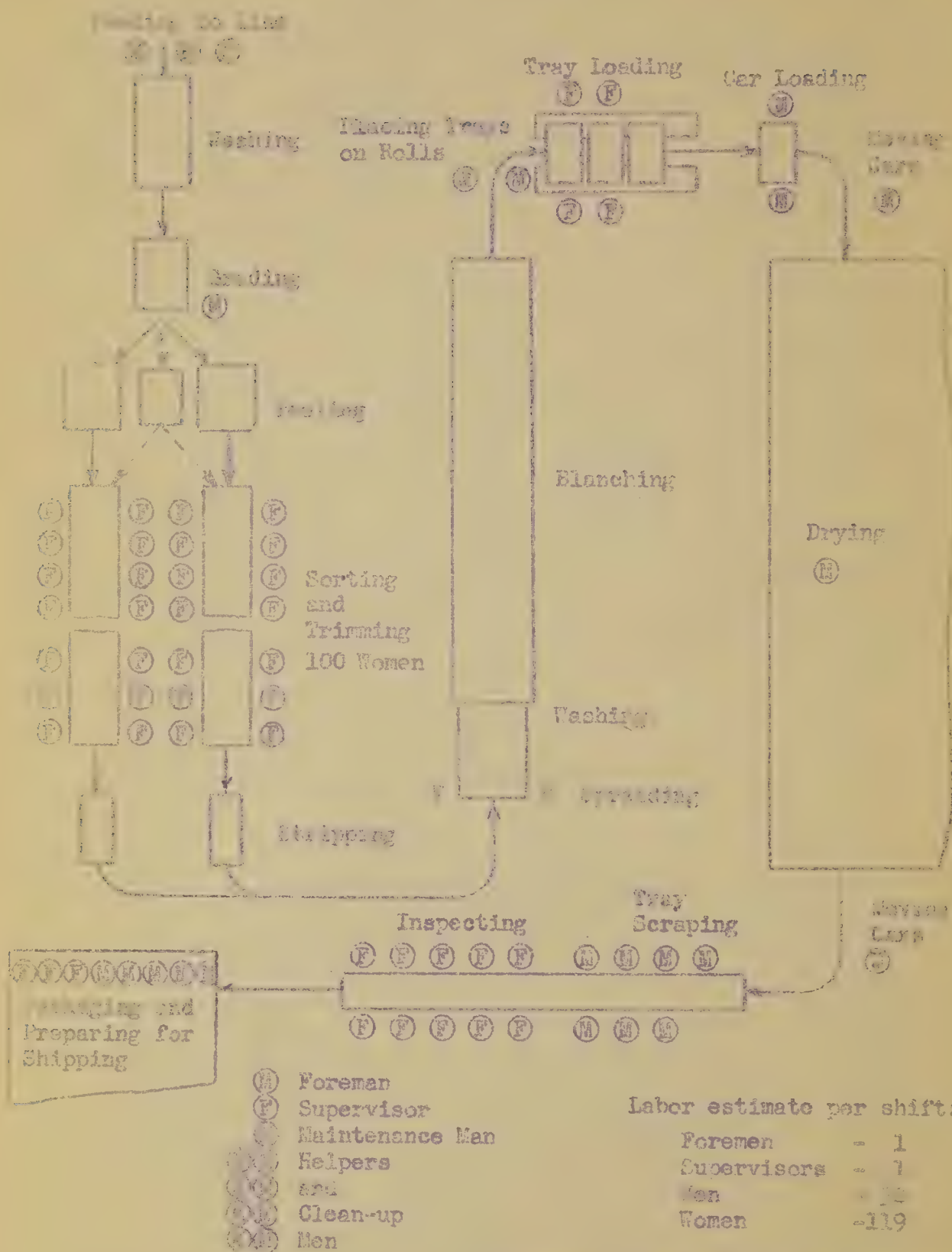


Prepared by the Dehydration Committee,  
Bureau of Agricultural Chemistry and  
Engineering, United States Department  
of Agriculture, August 1942.

# DEHYDRATION FLOW SHEET

8330 Pounds per Hour

Unprepared Basis



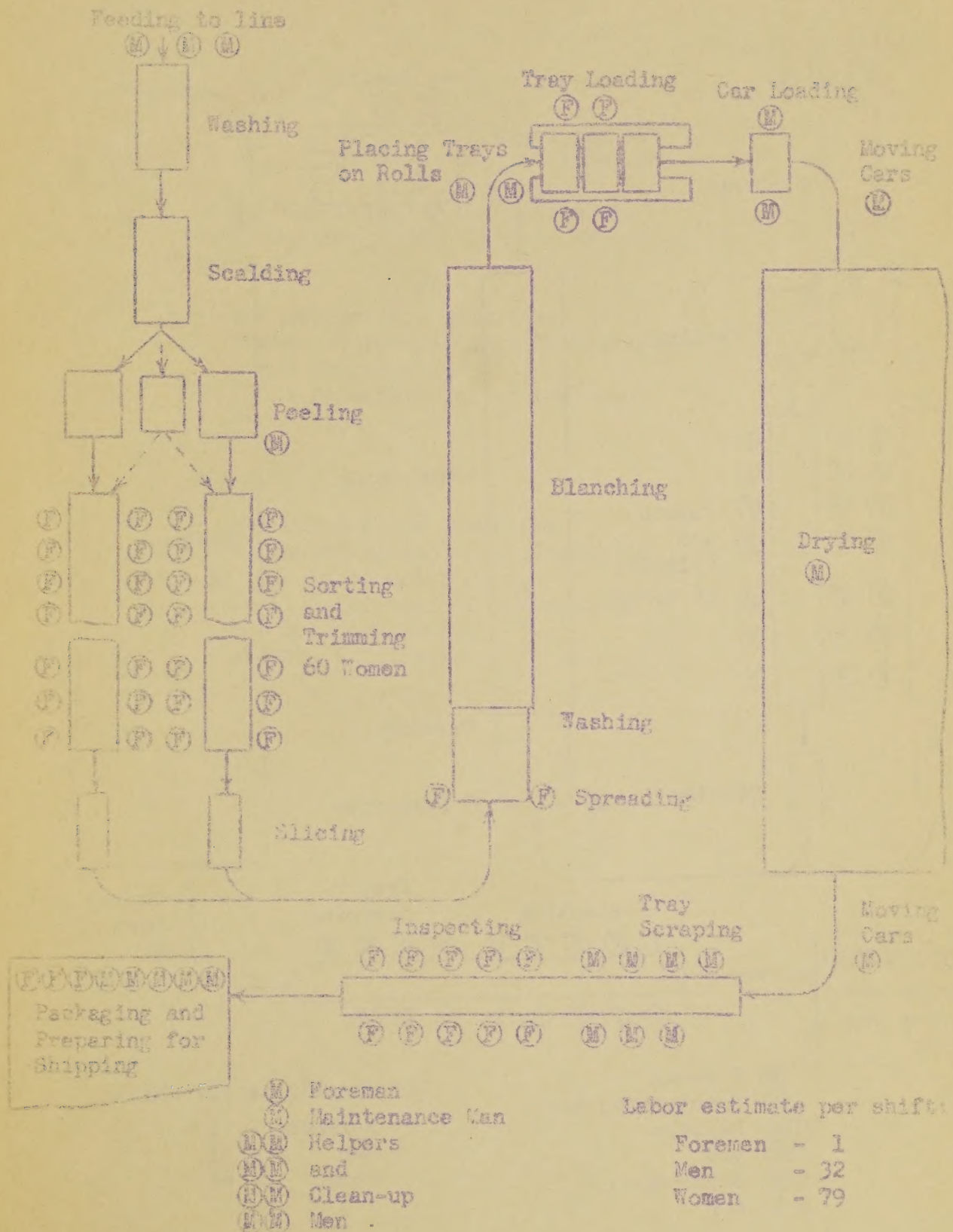
Prepared by the Dehydration Committee,  
Bureau of Agricultural Chemistry and  
Engineering, United States Department  
of Agriculture, August 1942.



# DEHYDRATION FLOW SHEET

8350 Pounds per Hour

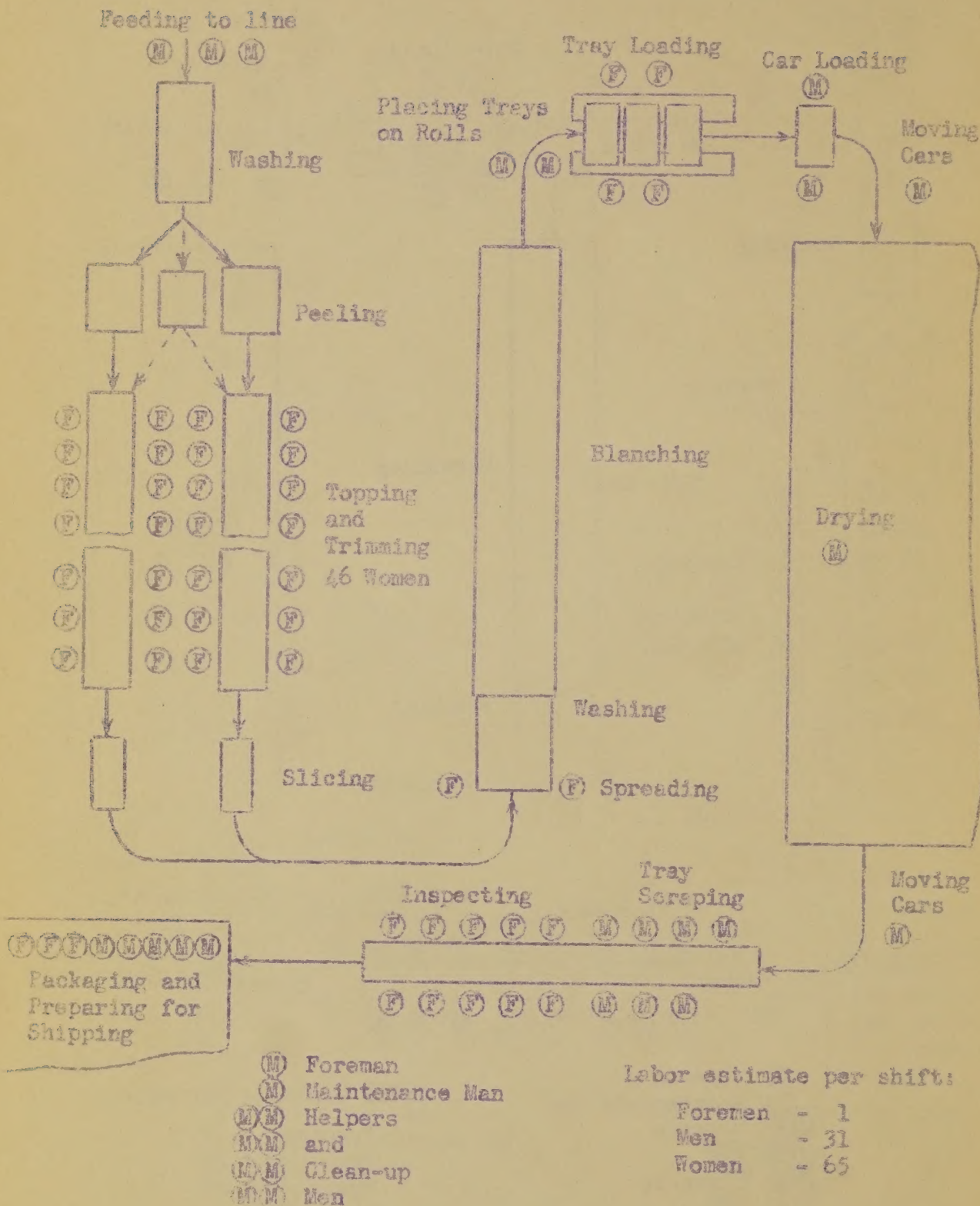
Unprepared Basis



Prepared by the Dehydration Committee,  
Bureau of Agricultural Chemistry and  
Engineering, United States Department  
of Agriculture, August 1942.



TURNIPS  
DEHYDRATION FLOW SHEET  
8330 Pounds per Hour  
Unprepared Basis





If further detailed information is  
desired, inquiries should be addressed  
to:

The Dehydration Committee  
Bureau of Agricultural Chemistry  
and Engineering  
U. S. Department of Agriculture  
Washington, D. C.

or to

The Dehydration Committee  
Bureau of Agricultural Chemistry  
and Engineering  
U. S. Department of Agriculture  
800 Buchanan Street  
Albany, California

